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Lake Fenwick Restoration Project

Kent City Parks and Recreation Dept., WA

Prepared for:

Washington State Dept. of Ecology, Olympia

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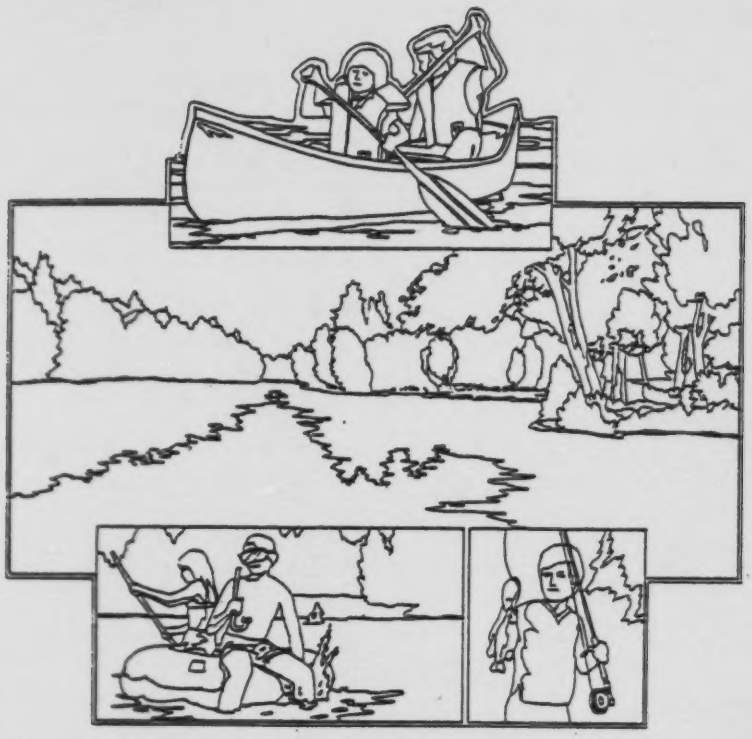

Lake Fenwick Restoration Project

Submitted to the
Environmental Protection Agency
and Department of Ecology

Submitted By
City of Kent
Parks and Recreation Department

Prepared By URS Company Seattle

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FINAL REPORT

LAKE FENWICK RESTORATION PROJECT

SUBMITTED TO:

Carl Nadler
Project Officer
EPA, Region 10

Ron Pine
Project Officer
DOE, Central Office

SUBMITTED BY:

Helen Adams
Administrative Assistant
City of Kent
Parks and Recreation Department

PREPARED BY

URS Company
4th and Vine Building
P.O. Box 21209
Seattle, Washington 98111

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Lake Fenwick, WA had stormwater runoff-induced sedimentation and blue-green algae (taste and odor problems). Diversion of stream flows through sedimentation pond reduced phosphorus and suspended solids loading, but there was no significant change in nutrient levels. Chlorophyll a concentration was higher and blue-greens were still dominant. This report was prepared in partial fulfillment of the requirements of an EPA Clean Lakes Program grant.

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CHAPTER 1

INTRODUCTION

The purpose of this report is to present results of the post-construction monitoring program for the Lake Fenwick Restoration Project.

The Lake Fenwick Restoration Project was initiated by the Parks and Recreation Department, City of Kent, Washington, when concerns over stormwater runoff and sedimentation in Lake Fenwick and its inlet stream appeared to conflict with plans for development of the City of Kent's Lake Fenwick Park. The location of Lake Fenwick is shown on Figure 1.

In December 1977 URS Company submitted a report to the City which included four recommendations addressing the stormwater induced sedimentation:

1. Eliminate existing erosion in the inlet stream by diverting excessive stream flows from the head of the inlet stream ravine to a natural pond within the park.

2. Provide stream channel stabilization through "non-structural" means, compatible with the Park Plan.

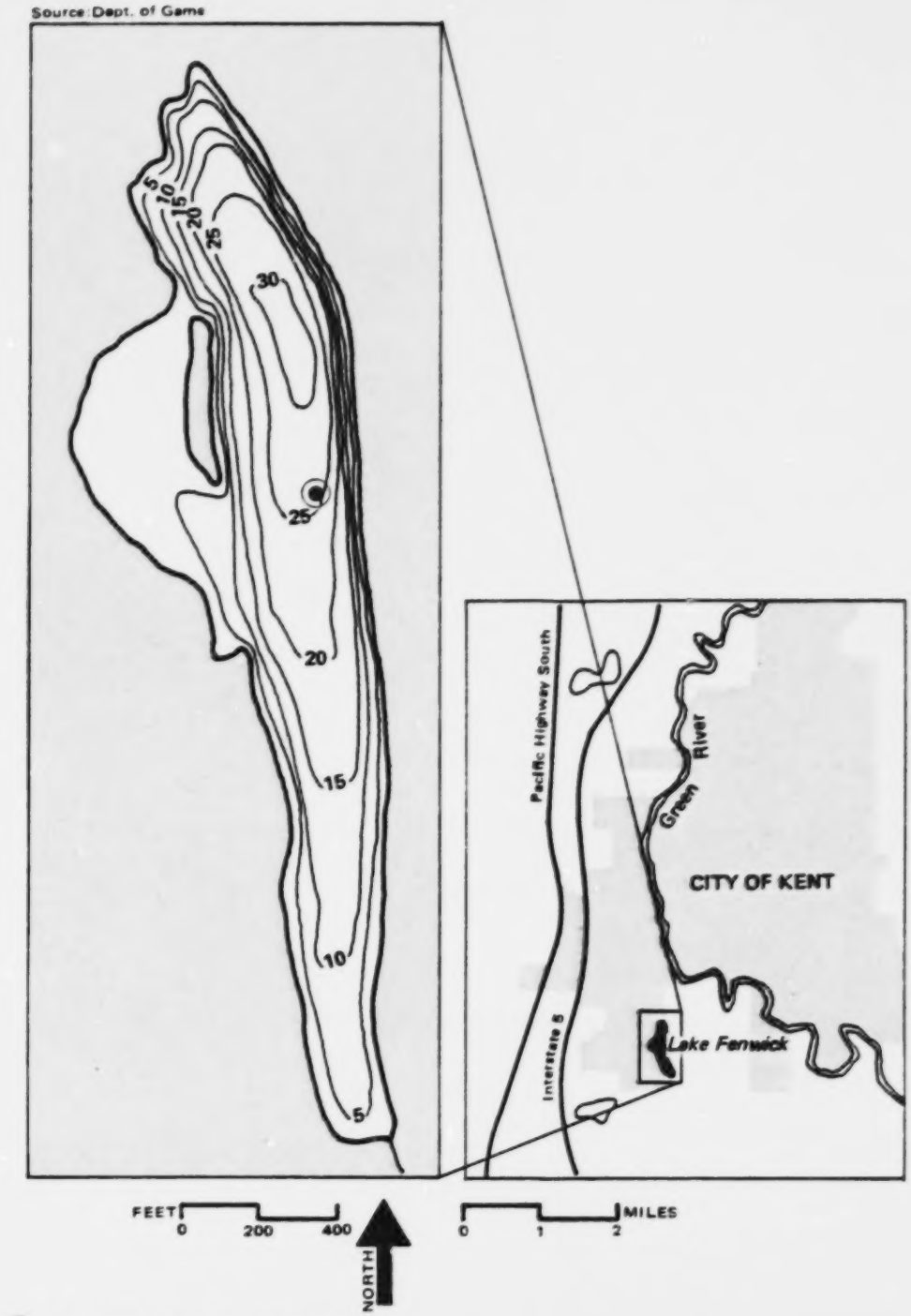


Figure 1
Lake Fenwick Area Map

3. Prevent erosion and sedimentation in other portions of the Lake Penwick Watershed by continuing technical assistance to developers for Best Management Practice (BMP) use, whether by continuing the conservation plan contract with the Soil Conservation Service/King County Conservation District or through a program implemented by the Kent Public Works Department; and enacting an effective "urban drainage" or "surface water management" ordinance.

4. Monitor the effectiveness of solution implementation in the Lake Penwick Watershed by continuing future water quality monitoring.

The City of Kent applied for and received lake restoration grant funds from the EPA and DOE, using the above report as documentation of the erosion/sedimentation, engineering analyses, and recommended alternative.

In awarding the agency grants to the City, special grant conditions were established to evaluate additional alternatives and obtain more complete documentation of the erosion and sedimentation problem. These grant conditions also established the first significant monitoring program of Lake Penwick's biological and nutrient conditions. A summary of these grant conditions and the work tasks to fulfill them is presented in Table 1.

TABLE 1

SUMMARY OF AGENCY GRANT CONDITIONS

Item	EPA Grant Condition	DOE Grant Condition	Work Tasks
1	5(a)(1)	I.B	Stormwater Monitoring May-December, 1979
2	5(a)(2)	I.A	Limnological Monitoring May-December, 1979
3	5(c)	III.C and IV.A & B	Revegetation Plan and Stream Stabilization
4	5(e)	III.B	Additional Analysis on the recommended alternative (sedimentation basin)
5	6(a)	I.C	Post Construction Limnological Monitoring
6	6(b)	I.C.	Post Construction Stormwater Monitoring
7	5(d)(1)	III.A	Analysis of additional restoration alternatives
8	1	II	Prepare quarterly progress reports

A second document entitled "Lake Fenwick Restoration Workplan" was submitted to the funding agencies in February, 1980, to fulfill the requirements of items 1, 2, 4 and 7. That report presented the results of a lake and stormwater monitoring program and a detailed engineering analysis.

The 1979 inlet stream/stormwater monitoring study concluded that erosion of the inlet stream bed contributed at least 90 percent of the total sediment load and at least 50-60 percent of the total suspended sediment to the lake. The stream also contributed about 50 percent of the total phosphorus entering the lake.

The 1979 lake monitoring program showed that Lake Fenwick was dominated during the recreational season by blue-green algae and other species indicative of water quality problems. Comparison of the lake to other western Washington lakes showed that biological and nutrient conditions exhibited an enriched condition.

The engineering analysis investigated several further alternative solutions and confirmed the technical and cost effectiveness of the proposed stormwater diversion. It was estimated that the diversion and sedimentation pond would result in over 90 percent reduction in total sediment load to the lake.

Finally, the "Workplan" made two major recommendations: 1) design and construction of the recommended facilities should proceed and 2) steps should begin to implement a further study of in-lake biological/nutrient conditions and alternative in-lake restoration techniques.

The first recommendation was implemented. Construction bids were opened in July, 1980, and construction began in August. Diversion of all inlet stream flows through the sedimentation pond began in the fall and the post-construction monitoring program, discussed in this report, began in January, 1981. Final construction was completed in May, 1981.

Further discussion between the City, funding agencies, and the consultant resulted in the decision to postpone consideration of further in-lake studies until the results of the post-construction monitoring program could demonstrate whether or not the sedimentation pond was effective in removing phosphorus. This issue will be discussed in this report.

This document is the final product of the present grant and fulfills the requirements of items 5 and 6 of the grant conditions.

CHAPTER 2

METHODOLOGY

DISCHARGE MEASUREMENTS

Measurements of discharge at the pond inlet and outlet were made using Stevens continuous stage recorders with floats located in adjacent wells. A nearly complete record of flows was obtained between December 15, 1980 and December 16, 1981.

Stage-height control at the inlet was accomplished using a standard four foot Cippolletti wier mounted between the wing walls of the inlet structure where flows exit the diversion pipe.

Outlet flows were determined by measuring stage height of the pond itself. A rating curve was developed by current meter measurement of flows in the pond's outlet stream under different flow conditions.

Another Cippolletti wier at the lake outlet with manual height measurements was used to record instantaneous flows from the lake.

FIELD WORK

Limnological and stormwater monitoring occurred from January 1981 through December 1981. Routine lake monitoring

occurred twice monthly from May through August and monthly at other times. Three storms were sampled, one each in July, November and December. The lake was also sampled following each storm. Station locations are shown in Figure 2.

Routine Lake Monitoring

Lake water column *in situ* measurements for depth, temperature, conductivity, and pH were made with a Martek-Mark VI Water Quality Analyzer. Discrete samples were collected for dissolved oxygen and nutrient analysis by a three liter Kahl Scientific water bottle at equal intervals to a depth of 6.1 meters. Euphotic zone depths were determined using a Kahl Scientific submarine photometer (Model No. 268WA310). Phytoplankton, total suspended solids, chlorophyll *a*, hardness, and alkalinity lake samples were also collected by a water bottle at equal intervals throughout the euphotic zone and composited aboard the boat.

A 300 ml phytoplankton sample was preserved with Lugol's solution (A.P.H.A., 1976). Vertical zooplankton tows from 6.5 meters to the surface were made with a #20 mesh (76 mm) plankton net (diameter, .5 meter) equipped with a #20 mesh cup. Collections were preserved in the field with formaldehyde (final solution 3.7 percent) and stained in the lab with 1.0 ml of saturated Eosin Y-ethanol solution and 0.5 ml of Lugol's solution. All zooplankton samples were then brought up to a final volume of 300 ml.

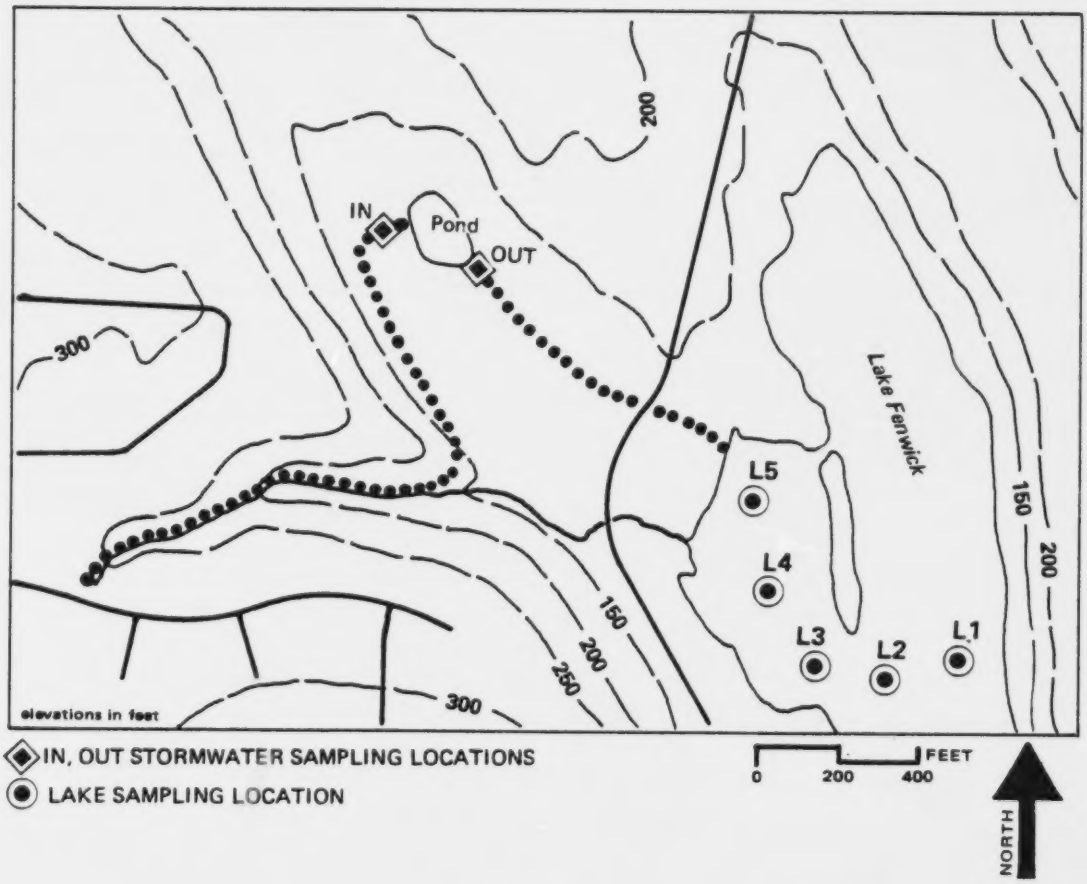


Figure 2
Stormwater and Lake
Sampling Locations

Stormwater Monitoring

Two discrete samplers were used to collected stormwater samples. One was located at the inlet and another at the outlet of the pond. A rain gauge with a pressure switch was used to initiate sampling when 0.1 inches of rain had accumulated in a period of 4 or less hours. The samplers collected 1 liter samples at preset intervals (usually 20 to 30 minutes). Ten samples each from the inlet and outlet were analysed for nutrients and suspended solids for each storm. The samplers were loaned to the City and set-up assistance was provided by METRO.

The lake was sampled for stormwater effects the day after each storm. Five stations were occupied, three in the northwest bay and two in the main part of the lake (Figure 2). Samples were collected at two depths at each station and were analysed for nutrients and suspended solids. Secchi depths were also taken at each station.

LABORATORY

Chemical and physical samples, packed in ice, were transported to the lab immediately after sampling. Table 2 summarizes the analytical methodologies. All filtrable nutrient analyses were conducted on samples filtered with pre-washed 0.45 micron membrane filters. Duplicate analyses were routinely conducted for quality assurance.

APPENDIX A

CHEMICAL AND PHYSICAL DATA

TABLE 2

CHEMICAL/PHYSICAL ANALYTICAL METHODS

Analysis	Method	Reference
Total Phosphate	Ascorbic Acid	APHA-AWWA-WPCF (1975)
Filtrable Orthophosphate	Ascorbic Acid	EPA (1974)
Filtrable Ammonia	Phenate with Distillation	APHA-AWWA-WPCF (1975)
Filtrable Nitrate/ Nitrite Nitrogen	Cadmium Reduction	EPA (1974)
Residue, Total Filtrable	103-105 C	EPA (1974)
Residue, Total Non-Filtrable	103-105 C	EPA (1974)
Alkalinity (Phenolphthalein and methyl-orange)	Titration	APHA-AWWA-WPCF (1975)
Hardness (Total and Calcium)	Titration	APHA-AWWA-WPCF (1975)

Ten milliliters of the phytoplankton composite sample or an appropriate dilution were poured into a sedimentation chamber. After a minimum of 12 hours the sediment was examined with a Nikon inverted phase microscope. Phytoplankton were identified to species where possible following the nomenclature of Smith (1950), Prescott (1962), and Patrick and Reimer (1966, 1975). Algal cells (colonies) were counted and representatives of each taxon were measured using a Whipple micrometer to determine various morphological dimensions. Average cell volume was

calculated from linear measurements by utilizing the appropriate volume formulae according to geometric shape. A visual estimate of cellular contribution was made in cases where there were many air spaces or matrix material associated with colonial algal genera. Mean phytoplankton biovolume per liter was calculated as described by Schwoerbel (1970). Cells smaller than five microns or with distorted morphological features making identification impossible were placed in the general category of microplankton.

Zooplankton were identified to species according to Edmondson (1959), Brooks (1957), and Ruttner-Kolisko (1974) and enumerated according to the procedure outlined by Edmondson and Winberg (1971) in a modified rotary counting chamber (Ward, 1955). Successive subsamples were counted until either 100 organisms or ten 2 ml aliquots had been examined. A minimum of three subsamples were always counted. Total numbers from each subsample were analyzed using a chi square test to ensure subsample homogeneity.

DATA PROCESING

Data Management

Data management was divided into three phases: (1) data base planning, (2) data entry and verification, and (3) data analysis.

The SAS (SAS Institute, Inc., 1979) was selected as the data base management software package. This system is a combined data

base management and statistical analysis package. Its interactive and batch processing capabilities met the requirements of the project.

The basic data design was a chronological record for all variables. This design was implemented and tested with a small data set in preparation for all subsequent data.

The primary variables in the data base that formed the foundation were station number, day, month, year, and sample type. These were common to all the data sets (e.g., chemical, phytoplankton). SAS subsequently merged select data sets to form the primary working data sets.

As laboratory analyses were completed and the raw data reduced, values were compiled and keyboard-entered into the computer directly. The data were read, tabulated, and immediately returned for editing. After all edits to the initial data were completed, an SAS data set was constructed; and a sorted tabular listing was generated and verified.

Data Analysis

Once data were entered, verified, and placed into a data set, analysis began. Of the many analyses that SAS offers, the most frequent use was made of the summary and report writing features. SAS also produced simple plots for interpretation. Examples of the many types of analytical procedures used follow in the report.

CHAPTER 3

RESULTS AND DISCUSSION

ROUTINE LAKE MONITORING

Nutrient Results

The results of monitoring lake nutrients are summarized in Table 3. Vertical profiles of the season-averaged nutrient data are presented in Figure 3. A complete listing of all chemical and physical data is presented in Appendix A. At times the concentrations of orthophosphate, ammonia, and nitrate plus nitrite were below detection limits. These limits are 0.005 mg/l for orthophosphate and ammonia and 0.010 mg/l for nitrate plus nitrite. When concentrations were below detection limits, values of .003 and .008 mg/l were used for calculations and to distinguish from concentrations at the detection limit.

The mean total phosphorus concentration (TP-P) throughout the entire monitoring period and throughout the water column was 0.043 mg/l P. In the surface water, the mean TP-P concentration was 0.031 mg/l P while in the bottom waters the mean concentration was 0.080 mg/l P. During lake stratification total phosphorus values ranged from 0.187 to <.005 mg/l P. Mean values ranged from 0.024 mg/l P at 1.2 m to 0.094 mg/l P at the bottom. After turnover, values ranged from 0.014 to 0.095 mg/l P. Mean surface and bottom values were .030 mg/l P and .045 mg/l P respectively.

TABLE 3A

STATISTICS FOR PARAMETERS THROUGHOUT WATER COLUMN
DURING STRATIFICATION MARCH THROUGH SEPTEMBER
VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	60	14.211	5.283	5.990	25.570
D_O	60	5.152	4.190	0.000	11.100
COND	54	92.148	38.276	58.000	221.000
PH	60	6.832	0.265	6.200	7.300
TP_P	60	0.044	0.042	0.003	0.187
OP_P	58	0.009	0.016	0.003	0.070
NO3NO2_N	60	0.026	0.039	0.008	0.186
NH3_N	60	0.033	0.066	0.003	0.270
TKN_N	60	0.493	0.144	0.220	0.880

STATISTICS FOR PARAMETERS THROUGHOUT WATER COLUMN
AFTER TURNOVER OCTOBER THROUGH FEBRUARY
VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	24	9.395	3.779	5.620	15.660
D_O	23	5.743	2.119	0.000	9.100
COND	24	64.833	14.033	42.000	97.000
PH	24	6.871	0.300	6.400	7.500
TP_P	24	0.039	0.019	0.014	0.095
OP_P	24	0.007	0.005	0.003	0.019
NO3NO2_N	24	0.155	0.145	0.008	0.390
NH3_N	24	0.055	0.064	0.006	0.297
TKN_N	24	0.478	0.163	0.140	0.950

TABLE 3B

STATISTICS FOR PARAMETERS FROM DISCRETE DEPTHS IN WATER COLUMN
DURING STRATIFICATION MARCH THROUGH SEPTEMBER
VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

DEPTH_M=0.3

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	18.408	4.009	12.120	25.570
D_O	10	9.070	0.932	8.000	11.100
COND	9	101.333	46.220	68.000	221.000
PH	10	6.950	0.118	6.700	7.100
TP_P	10	0.032	0.055	0.003	0.187
OP_P	10	0.003	0.001	0.003	0.006
NO3NO2_N	10	0.028	0.037	0.008	0.116
NH3_N	10	0.011	0.005	0.003	0.019
TKN_N	10	0.441	0.117	0.220	0.590

DEPTH_M=1.2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	18.412	4.002	12.100	25.570
D_O	10	9.040	0.938	7.900	11.000
COND	9	99.778	43.897	68.000	213.000
PH	10	7.020	0.140	6.800	7.300
TP_P	10	0.024	0.014	0.003	0.052
OP_P	10	0.004	0.002	0.003	0.009
NO3NO2_N	10	0.019	0.026	0.008	0.092
NH3_N	10	0.009	0.008	0.003	0.026
TKN_N	10	0.456	0.110	0.280	0.620

DEPTH_M=2.4

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	17.439	4.250	9.740	23.490
D_O	10	8.760	1.315	7.000	11.000
COND	9	97.000	40.951	65.000	202.000
PH	10	7.050	0.158	6.700	7.300
TP_P	10	0.035	0.050	0.003	0.175
OP_P	10	0.004	0.001	0.003	0.007
NO3NO2_N	10	0.024	0.035	0.008	0.120
NH3_N	10	0.010	0.006	0.003	0.020
TKN_N	10	0.431	0.117	0.280	0.670

DEPTH_M=3.7

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	13.393	3.331	7.300	18.060
D_O	10	3.270	2.936	0.500	8.600
COND	9	88.111	36.988	60.000	184.000
PH	10	6.850	0.184	6.500	7.100
TP_P	10	0.039	0.026	0.018	0.107
OP_P	10	0.004	0.002	0.003	0.007
NO3NO2_N	10	0.031	0.055	0.003	0.186
NH3_N	10	0.011	0.004	0.006	0.016
TKN_N	10	0.458	0.156	0.250	0.730

DEPTH_M=4.9

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	9.703	1.597	6.340	11.390
D_O	10	0.570	0.267	0.300	1.000
COND	9	82.889	33.565	58.000	170.000
PH	10	6.630	0.221	6.400	7.000
TP_P	10	0.041	0.016	0.016	0.067
OP_P	9	0.003	0.001	0.003	0.006
NO3NO2_N	10	0.026	0.049	0.008	0.162
NH3_N	10	0.015	0.013	0.005	0.048
TKN_N	10	0.529	0.110	0.390	0.700

DEPTH_M=6.1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	10	7.919	0.989	5.990	9.400
D_O	10	0.200	0.275	0.000	0.900
COND	9	83.778	33.022	58.000	169.000
PH	10	6.490	0.191	6.200	6.800
TP_P	10	0.094	0.035	0.023	0.137
OP_P	9	0.039	0.025	0.003	0.070
NO3NO2_N	10	0.023	0.033	0.008	0.110
NH3_N	10	0.141	0.111	0.013	0.270
TKN_N	10	0.643	0.151	0.480	0.830

TABLE 3B (continued)

STATISTICS FOR PARAMETERS FROM DISCRETE DEPTHS IN WATER COLUMN
AFTER TURNOVER OCTOBER THROUGH FEBRUARY
VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

DEPTH_M=0.3

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	9.825	4.404	5.660	15.530
D_O	4	6.925	1.721	5.400	9.100
COND	4	62.750	17.877	42.000	85.000
PH	4	6.950	0.387	6.600	7.500
TP_P	4	0.030	0.012	0.015	0.042
OP_P	4	0.010	0.007	0.003	0.019
NO3NO2_N	4	0.159	0.170	0.008	0.360
NH3_N	4	0.039	0.037	0.014	0.093
TKN_N	4	0.477	0.045	0.420	0.530

DEPTH_M=1.2

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	9.827	4.440	5.660	15.590
D_O	4	6.025	1.828	5.200	9.100
COND	4	66.000	13.038	55.000	84.000
PH	4	6.950	0.311	6.600	7.300
TP_P	4	0.029	0.011	0.015	0.041
OP_P	4	0.006	0.004	0.003	0.012
NO3NO2_N	4	0.165	0.165	0.008	0.340
NH3_N	4	0.034	0.034	0.006	0.083
TKN_N	4	0.430	0.074	0.340	0.500

DEPTH_M=2.4

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	9.742	4.540	5.660	15.610
D_O	4	6.600	1.169	5.500	7.800
COND	4	64.500	13.026	54.000	83.000
PH	4	6.850	0.208	6.600	7.100
TP_P	4	0.047	0.034	0.017	0.095
OP_P	4	0.007	0.007	0.003	0.018
NO3NO2_N	4	0.172	0.185	0.011	0.390
NH3_N	4	0.089	0.139	0.010	0.297
TKN_N	4	0.442	0.242	0.140	0.730

DEPTH_M=3.7

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	9.682	4.628	5.660	15.660
D_O	4	6.350	1.047	5.400	7.400
COND	4	64.000	14.236	52.000	84.000
PH	4	6.800	0.183	6.600	7.000
TP_P	4	0.030	0.014	0.014	0.049
OP_P	4	0.005	0.005	0.003	0.012
NO3NO2_N	4	0.134	0.134	0.014	0.260
NH3_N	4	0.045	0.041	0.006	0.103
TKN_N	4	0.495	0.318	0.220	0.950

DEPTH_M=4.9

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	9.310	4.204	5.660	14.520
D_O	3	4.867	0.513	4.300	5.300
COND	4	63.250	13.961	52.000	83.000
PH	4	6.875	0.299	6.600	7.300
TP_P	4	0.051	0.023	0.033	0.084
OP_P	4	0.007	0.005	0.003	0.014
NO3NO2_N	4	0.150	0.155	0.008	0.300
NH3_N	4	0.042	0.035	0.011	0.088
TKN_N	4	0.455	0.099	0.310	0.530

DEPTH_M=6.1

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
W_TEMP_C	4	7.982	2.637	5.620	10.590
D_O	4	2.675	2.403	0.000	4.900
COND	4	68.500	20.567	52.000	97.000
PH	4	6.800	0.497	6.400	7.500
TP_P	4	0.045	0.010	0.034	0.055
OP_P	4	0.008	0.003	0.006	0.012
NO3NO2_N	4	0.147	0.164	0.008	0.330
NH3_N	4	0.083	0.053	0.011	0.132
TKN_N	4	0.567	0.105	0.450	0.700

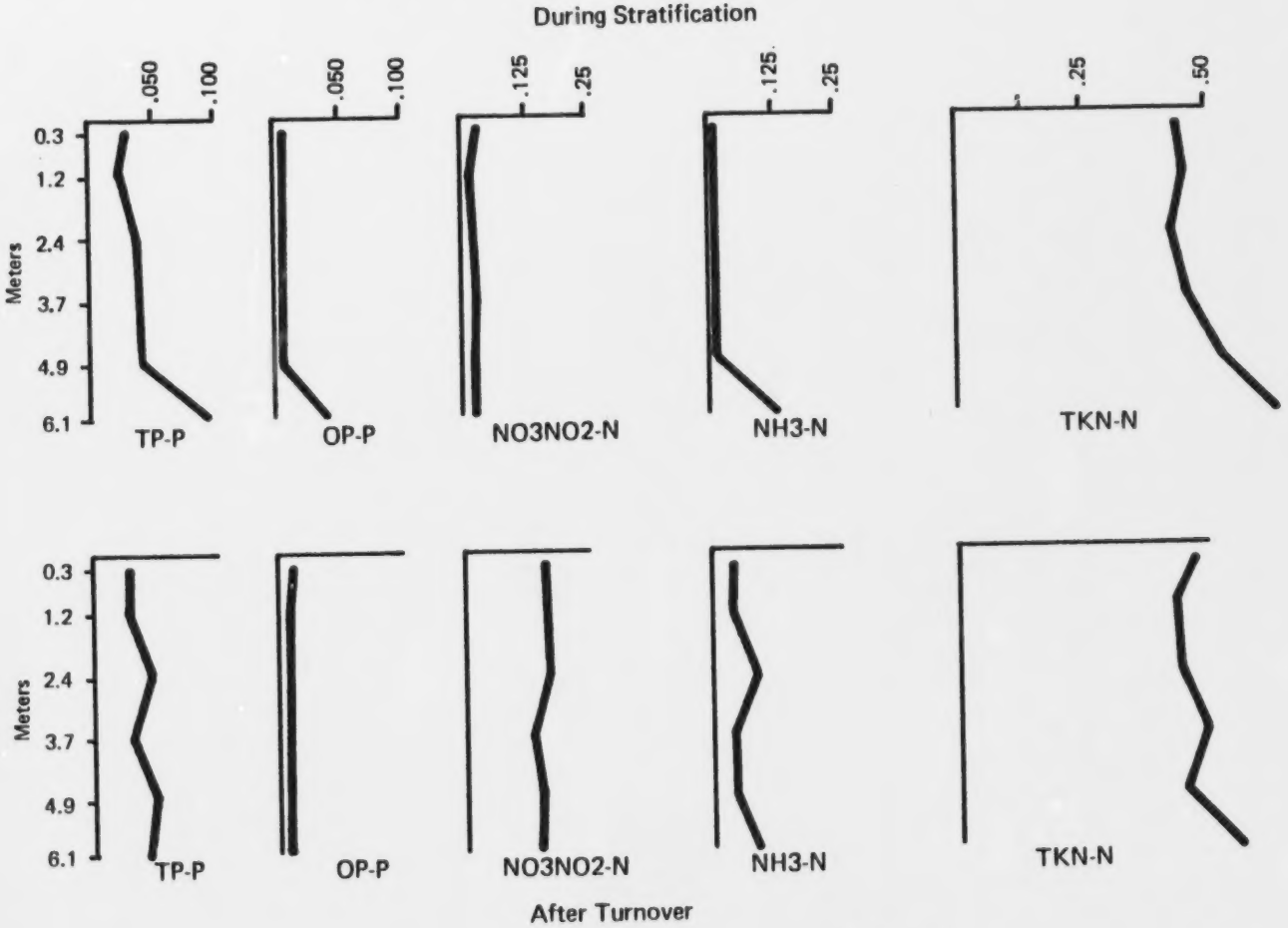


Figure 3
Vertical Profiles of Season-averaged Nutrient Data.
All Values Expressed as mg/l

Orthophosphate values (OP-P) ranged from <.005 to .070 mg/l P. The mean concentration was .008 mg/l P throughout the monitoring period and throughout the water column. Orthophosphate values averaged 20 percent of the total phosphorus during stratification and 18 percent after turnover. Orthophosphate values were usually at or below the detection limit in the upper 5 meters during stratification. This indicates that phosphorus was probably the nutrient limiting the growth of phytoplankton during this period.

The concentration of nitrate plus nitrite (NO_3NO_2-N) averaged 0.026 mg/l N during stratification and 0.155 mg/l N after turnover. Profiles at both times were fairly uniform with depth. Approximately one half of all samples collected during stratification had NO_3NO_2-N concentrations below the detection limit.

Ammonia concentrations (NH_3-N) averaged 0.033 mg/l N during stratification and 0.055 mg/l N after turnover. During stratification NH_3-N concentrations in the upper 4 m were low, averaging 0.010 mg/l N, but were infrequently below the detection limit. The low concentrations of NO_3NO_2-N and NH_3-N suggest that nitrogen may also be limiting at times.

Total Kjeldahl nitrogen concentrations (TKN-N) ranged from 0.140 to 0.950 mg/l N with a mean of 0.489 mg/l N throughout

the water column and throughout the monitoring periods. Concentrations during stratification and after turnover did not vary greatly.

Phytoplankton Results

Phytoplankton cell volume and abundance by species were determined for each sampling trip. Raw data are included in Appendix B.

Total phytoplankton cell volumes and counts for each sampling trip are shown in Table 4 and Figure 4. Chlorophyll a concentrations are also presented. Cell volumes ranged from 0.437 mm^3/l in January to a high of 3.348 mm^3/l in March. The mean phytoplankton cell volume during lake stratification (March through September) was 1.685 mm^3/l.

The summary of major phytoplankton taxonomic divisions is shown in Table 5. This summary data is plotted versus time in Figure 5.

Blue-green algae (Cyanophyceae) dominated phytoplankton cell volume in June, July, and late August. They were second in cell volume in February and October. Dominant blue-green species included Oscillatoria subbrevis, Anabaena sp., and Aphanizomenon flos-aquae. These algal species have been associated with taste and odor and filter clogging problems in water supplies and are generally considered polluted water algae (American Public Health Association, 1976).

TABLE 4

LAKE FENWICK PHYTOPLANKTON DATA
CELL VOLUME, ABUNDANCE, CHL__A

CELL VOLUME IN CUBIC MILLIMETERS PER LITER
ABUNDANCE IN NUMBERS PER LITER
CHLOROPHYLL A IN MICROGRAMS PER LITER

OBS	WHEN	CELL_VSM	COUNTSM	CHL_A
1	14JAN81	0.437	0.358	1.79
2	23FEB81	1.304	1.092	5.95
3	27MAR81	3.348	5.403	30.40
4	28APR81	1.807	3.628	25.10
5	12MAY81	2.363	7.922	7.68
6	28MAY81	0.626	2.876	3.17
7	10JUN81	1.605	7.506	9.71
8	25JUN81	2.767	4.497	6.08
9	09JUL81	1.263	3.319	7.73
10	23JUL81	1.294	7.487	13.80
11	11AUG81	0.534	4.895	4.08
12	27AUG81	1.242	10.341	16.70
13	02OCT81	2.298	22.383	17.80
14	04NOV81	1.909	7.615	10.90

FIGURE 4

LAKE FENWICK - PHYTOPLANKTON
TTL CELL VOLUME, ABUNDANCE, AND CHL A VERSUS TIME

CELL VOLUME IN CUBIC MILLIMETERS PER LITER
ABUNDANCE IN NUMBERS PER LITER
CHLOROPHYLL A IN MICROGRAMS PER LITER

PLOT OF CELL_VSM*WHEN SYMBOL USED IS *
PLOT OF COUNTSM*WHEN SYMBOL USED IS X
PLOT OF CHL_A*WHEN SYMBOL USED IS O

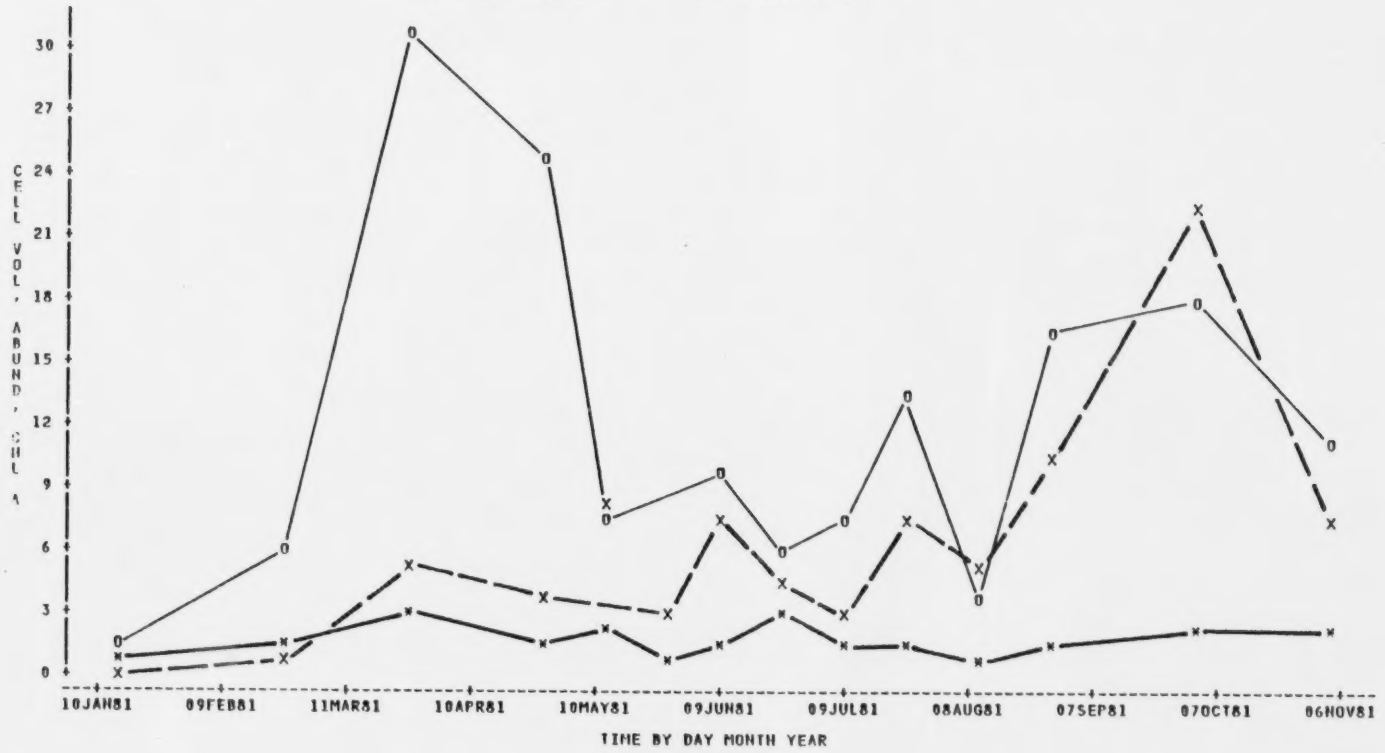


TABLE 5

LAKE FENWICK PHYTOPLANKTON SUMMARY BY MAJOR TAXONOMIC DIVISIONS

OBS	DIV_NO	CELL_V	MN	DAY	YR
1	CYANOPHYCEAE	0.006	1	14	81
2	MICROPLANKTON	0.026	1	14	81
3	CHRYSOPHYCEAE	0.073	1	14	81
4	CRYPTOPHYCEAE	0.332	1	14	81
5	MICROPLANKTON	0.013	2	23	81
6	CYANOPHYCEAE	0.121	2	23	81
7	CRYPTOPHYCEAE	1.170	2	23	81
8	CYANOPHYCEAE	0.027	3	27	81
9	MICROPLANKTON	0.051	3	27	81
10	EUGLENOPHYCEAE	0.088	3	27	81
11	BACILLARIOPHYCEAE	0.297	3	27	81
12	CHRYSOPHYCEAE	0.703	3	27	81
13	CRYPTOPHYCEAE	2.182	3	27	81
14	MICROPLANKTON	0.054	4	28	81
15	CRYPTOPHYCEAE	0.163	4	28	81
16	BACILLARIOPHYCEAE	0.214	4	28	81
17	CHLOROPHYCEAE	0.352	4	28	81
18	CHRYSOPHYCEAE	1.024	4	28	81
19	CRYPTOPHYCEAE	0.022	5	12	81
20	MICROPLANKTON	0.042	5	12	81
21	CYANOPHYCEAE	0.085	5	12	81
22	CHRYSOPHYCEAE	0.543	5	12	81
23	BACILLARIOPHYCEAE	1.671	5	12	81
24	MICROPLANKTON	0.050	5	28	81
25	CHRYSOPHYCEAE	0.151	5	28	81
26	CRYPTOPHYCEAE	0.181	5	28	81
27	BACILLARIOPHYCEAE	0.244	5	28	81
28	CRYPTOPHYCEAE	0.027	6	9	81
29	MICROPLANKTON	0.073	6	9	81
30	CHRYSOPHYCEAE	0.169	6	9	81
31	CHLOROPHYCEAE	0.262	6	9	81
32	CYANOPHYCEAE	1.074	6	9	81
33	CRYPTOPHYCEAE	0.081	6	25	81
34	MICROPLANKTON	0.086	6	25	81
35	BACILLARIOPHYCEAE	0.147	6	25	81
36	CHLOROPHYCEAE	0.576	6	25	81
37	CYANOPHYCEAE	1.877	6	25	81
38	CHRYSOPHYCEAE	0.063	7	9	81
39	CRYPTOPHYCEAE	0.084	7	9	81
40	MICROPLANKTON	0.215	7	9	81
41	CHLOROPHYCEAE	0.446	7	9	81
42	CYANOPHYCEAE	0.455	7	9	81
43	CHRYSOPHYCEAE	0.003	7	23	81
44	CHLOROPHYCEAE	0.069	7	23	81
45	MICROPLANKTON	0.111	7	23	81
46	CRYPTOPHYCEAE	0.218	7	23	81
47	BACILLARIOPHYCEAE	0.318	7	23	81
48	CYANOPHYCEAE	0.575	7	23	81
49	BACILLARIOPHYCEAE	0.025	8	11	81
50	CRYPTOPHYCEAE	0.031	8	11	81
51	CHLOROPHYCEAE	0.054	8	11	81
52	MICROPLANKTON	0.138	8	11	81
53	CHRYSOPHYCEAE	0.286	8	11	81
54	CRYPTOPHYCEAE	0.036	8	27	81
55	MICROPLANKTON	0.046	8	27	81
56	CHLOROPHYCEAE	0.049	8	27	81
57	DINOPHYCEAE	0.105	8	27	81
58	CHRYSOPHYCEAE	0.114	8	27	81
59	BACILLARIOPHYCEAE	0.413	8	27	81
60	CYANOPHYCEAE	0.479	8	27	81
61	CHLOROPHYCEAE	0.008	10	2	81
62	MICROPLANKTON	0.045	10	2	81
63	CRYPTOPHYCEAE	0.056	10	2	81
64	CYANOPHYCEAE	0.939	10	2	81
65	BACILLARIOPHYCEAE	1.250	10	2	81
66	CHLOROPHYCEAE	0.005	11	4	81
67	CHRYSOPHYCEAE	0.008	11	4	81
68	MICROPLANKTON	0.071	11	4	81
69	CYANOPHYCEAE	0.111	11	4	81
70	CRYPTOPHYCEAE	0.378	11	4	81
71	UNKNOWN	0.455	11	4	81
72	BACILLARIOPHYCEAE	0.881	11	4	81

FIGURE 5

BAR CHART OF CELL_V

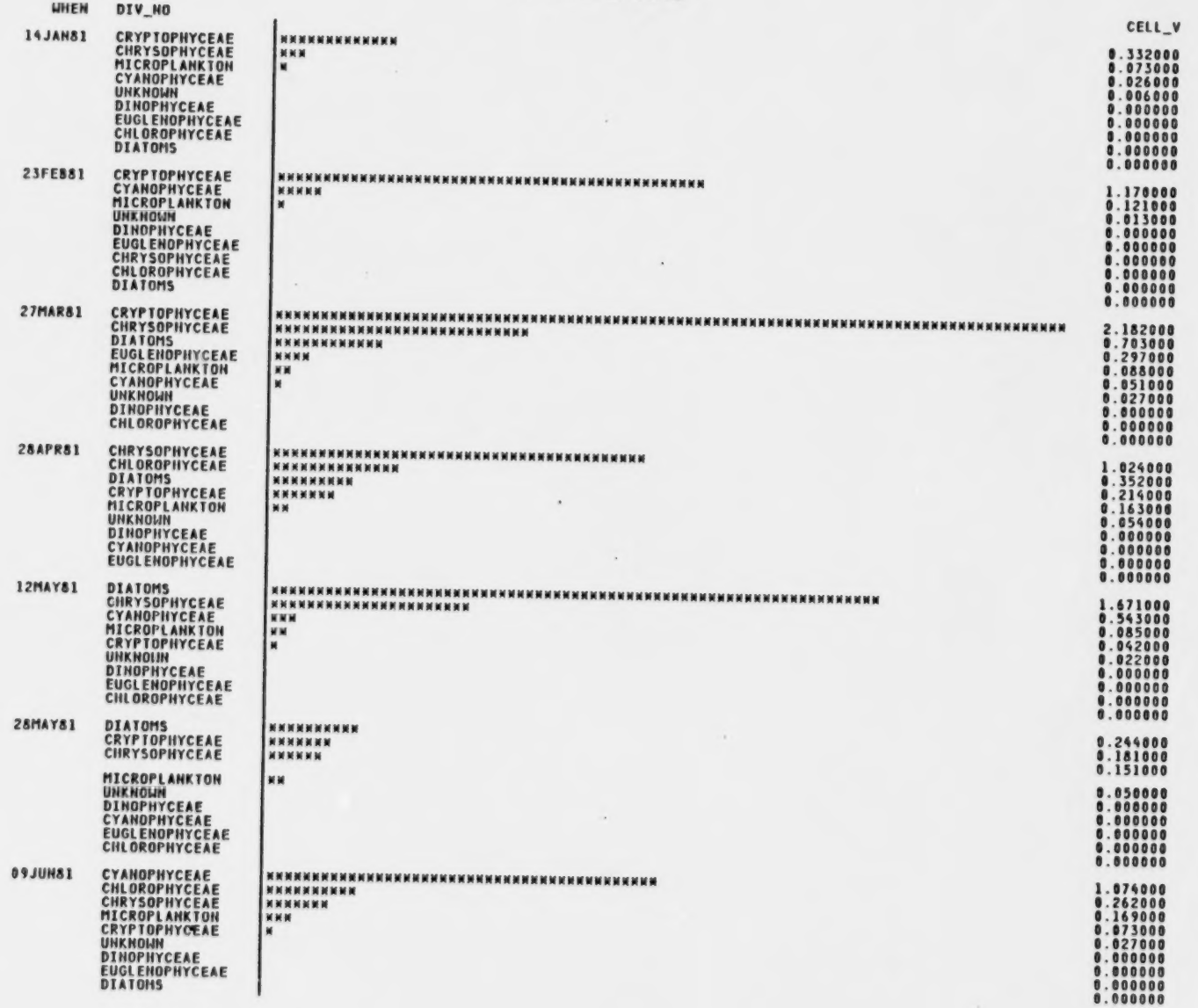
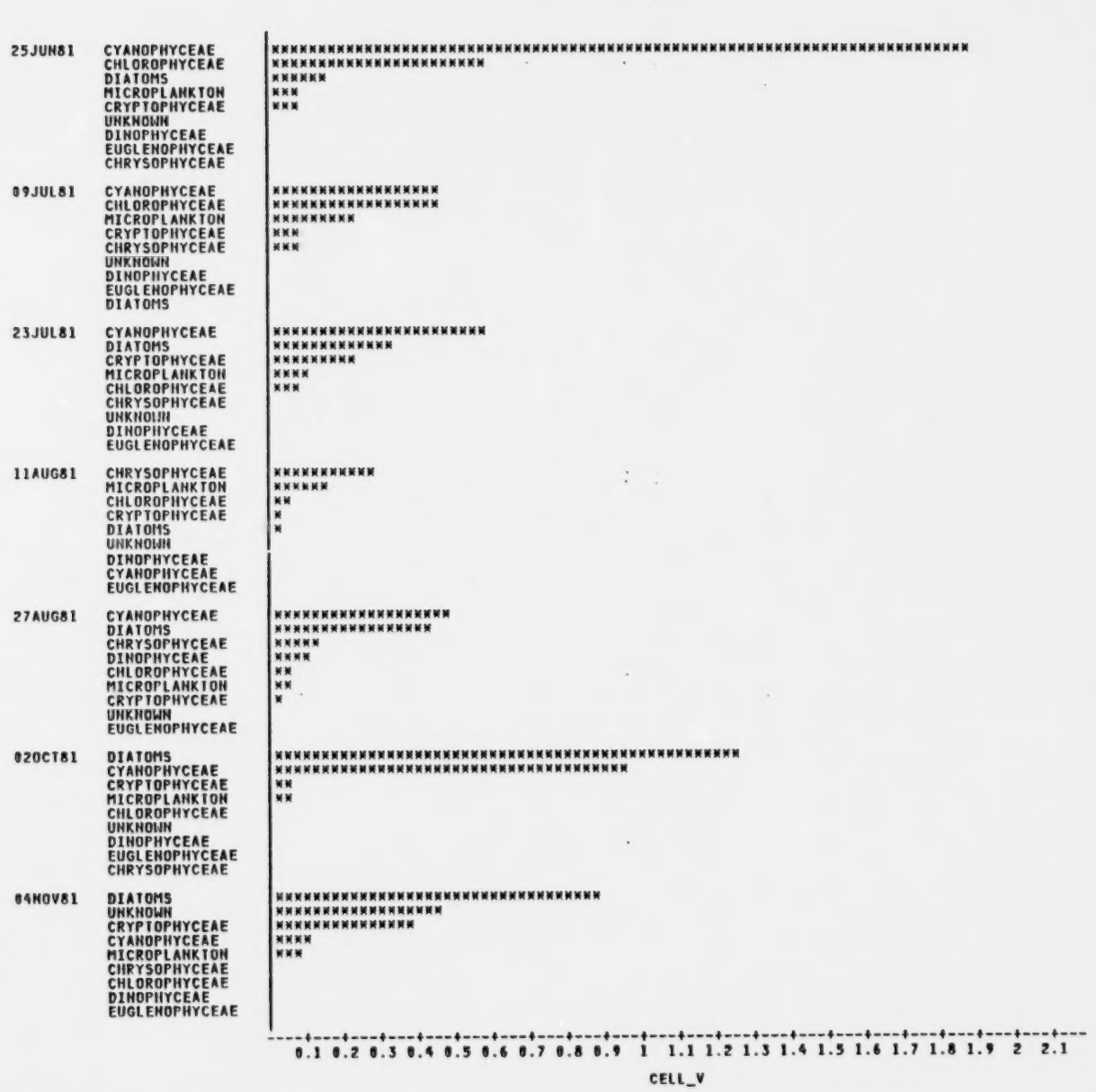


FIGURE 5(continued)

BAR CHART OF CELL_V



Yellow-green algae (Chrysophyceae) were dominant in April and mid-August; they were second in cell volume in January, March, and mid-May. Dominant Chysophyceae species included Dinobryon sp. and Mallomonas sp. which are associated with taste and odor problems.

Cryptophyceae cell volumes dominated in January, February and March with secondary dominance in late May. The dominant Cryptophyceae species was Cryptomonas sp. Diatoms were dominant in May, October and November. Dominant diatom species were Melosira granulata and Asterionella formosa which are considered to be filter clogging algae.

Zooplankton Results

Zooplankton abundance by species was determined for each sampling trip. Raw data are included in Appendix B.

The summary of major zooplankton taxa is shown in Table 6. The abundance of major taxa versus time is plotted in Figure 6. Rotifers dominated throughout the year. Copepods were second in dominance at all times except in January when Cladocer abundance was greater. Zooplankton abundance was highest in November followed by March, April, late June, and mid-May.

In January, February, and April zooplankton abundance was dominated by Keratella cochlearis. This rotifer became second in abundance in March and mid-May. Polyarthra vulgaris, another rotifer was most abundant in March and late-May. In April and

TABLE 6

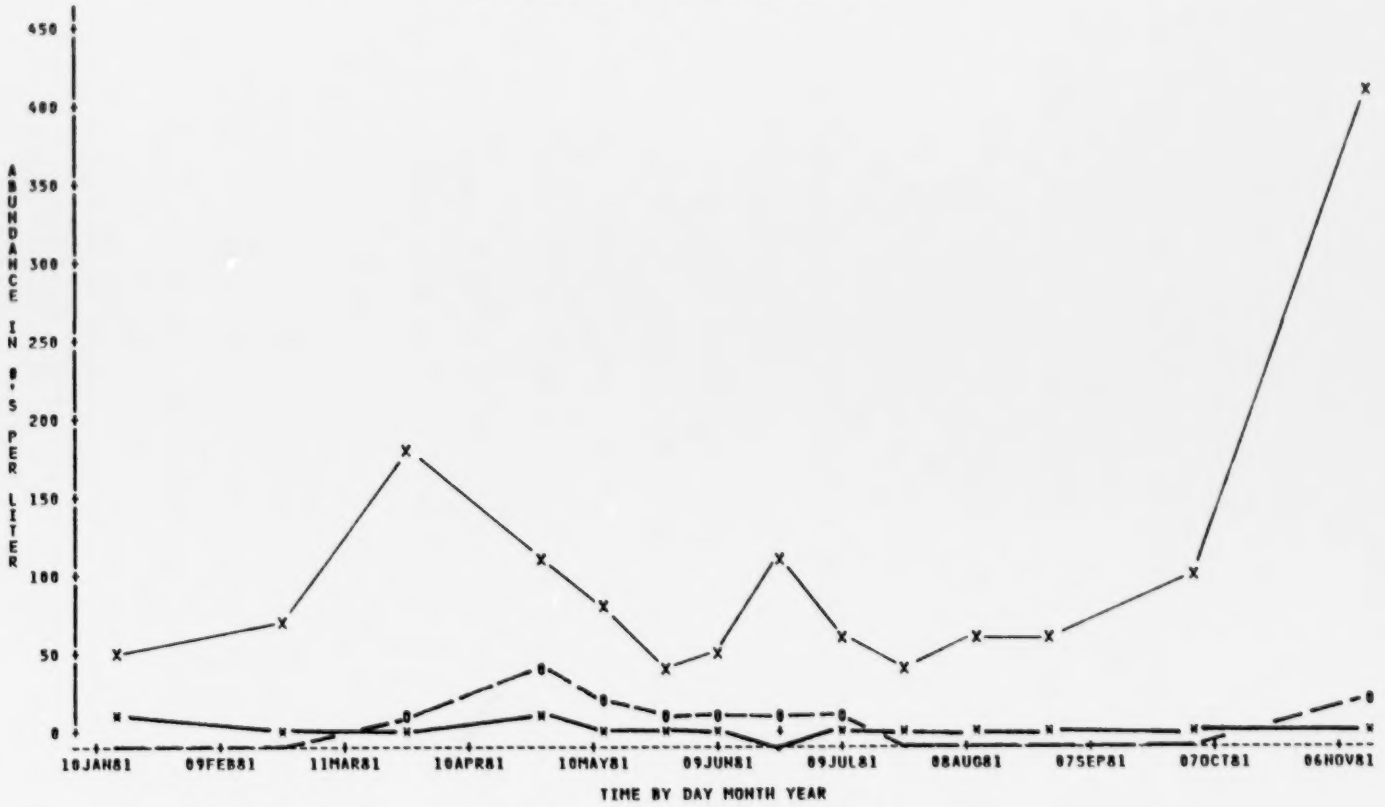
LAKE FENWICK ZOOPLANKTON SUMMARY BY MAJOR TAXA

OBS	WHEN	CLADOCER	COPEPODA	ROTIFERA	DIPTERA
1	14JAN81	9.250	6.26	53.12	.
2	23FEB81	0.630	4.07	73.96	.
3	27MAR81	0.630	8.77	183.85	.
4	28APR81	6.816	39.18	114.67	.
5	12MAY81	3.290	17.87	82.77	.
6	28MAY81	1.040	12.96	44.91	.
7	09JUN81	2.980	5.64	54.53	0.16
8	25JUN81	.	7.50	112.97	0.55
9	09JUL81	0.520	6.00	59.81	0.26
10	23JUL81	0.520	2.60	41.51	0.52
11	11AUG81	1.180	1.41	64.43	0.94
12	27AUG81	0.710	1.18	56.24	0.94
13	02OCT81	2.960	4.07	95.46	.
14	14NOV81	0.440	15.24	407.87	.

FIGURE 6

PLOT OF MAJOR ZOOPLANKTON TAXA VS TIME

PLOT OF CLADOCER*WHEN SYMBOL USED IS W
PLOT OF COPEPODA*WHEN SYMBOL USED IS 0
PLOT OF ROTIFERA*WHEN SYMBOL USED IS X
PLOT OF DIPTERA*WHEN SYMBOL USED IS +



NOTE: 9 OBS HAD MISSING VALUES

late-May, Copepod nauplii were second in abundance. Asplanchna priodonta was most abundant in mid-May. In June another rotifer Filinia longiseta was dominant. Pompholyx sulcata was second in abundance in late June and late August and was dominant through July and mid-August. Ascomorpha sp. was most abundant in late-August and October. In November the rotifer Pompholyx sulcata was again most abundant with Polyarthra vulgaris second in dominance.

Euphotic Zone Composite Date

The Euphotic zone composite data are summarized in Table 7. The secchi depth was slightly less after turnover averaging 2.2 m compared with 2.7 m during stratification. Total suspended solids (TSS) were somewhat greater after turnover probably due to resuspension of detritus. Chlorophyll a was less after turnover averaging 9.1 ug/l compared with 12.4 ug/l during stratification. Both values are considered to be fairly high. Alkalinity and hardness showed no significant differences between seasons.

Chlorophyll a concentrations and secchi depths are plotted in Figure 7. These parameters are not linearly correlated. Also, there is no linear correlation between secchi depth and TSS.

TABLE 7

STATISTICS FOR EUPHOTIC ZONE COMPOSITE DATA
DURING STRATIFICATION MARCH THROUGH SEPTEMBER
VALUES ANALYZED FROM EUPHOTIC ZONE COMPOSITE SAMPLES
ALL DEPTHS EXPRESSED AS METERS
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
ALKALINITY AND HARDNESS AS MG/L CALCIUM CARBONATE

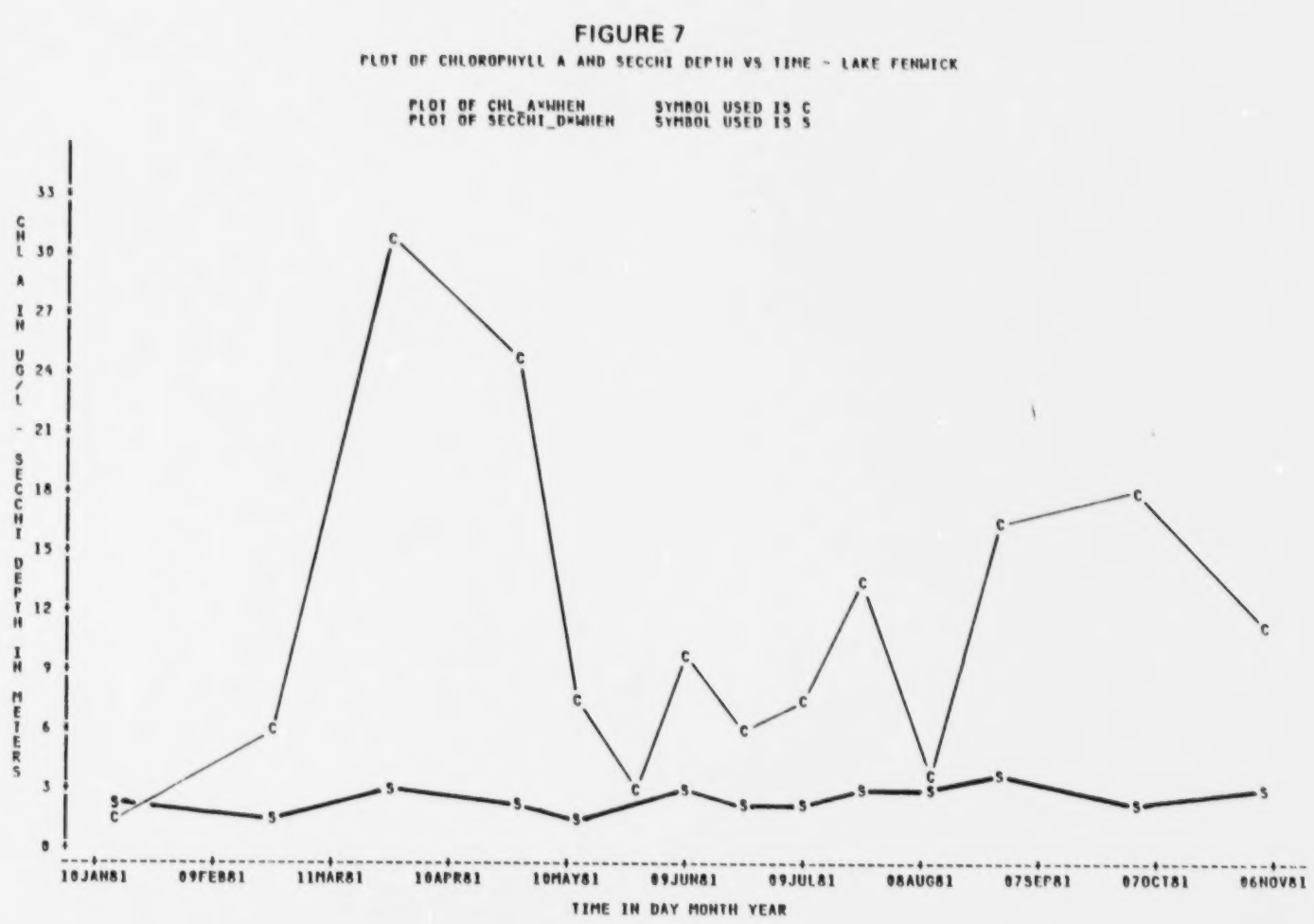
VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
SECCHI_D	10	2.7	0.5	1.5	3.4
TSS	10	2.1	1.0	1.0	4.0
CHL_A	10	12.4	9.1	3.2	30.4
TTL_HRDN	10	38.0	4.4	32.0	46.0
CA_HRDN	10	23.4	4.3	16.0	30.0
PPTH_ALK	10	0.0	0.0	0.0	0.0
MO_ALK	10	37.0	12.1	25.0	65.0

STATISTICS FOR EUPHOTIC ZONE COMPOSITE DATA
AFTER STRATIFICATION OCTOBER THROUGH FEBRUARY
VALUES ANALYZED FROM EUPHOTIC ZONE COMPOSITE SAMPLES
ALL DEPTHS EXPRESSED AS METERS
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
ALKALINITY AND HARDNESS AS MG/L CALCIUM CARBONATE

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
SECCHI_D	4	2.2	0.6	1.5	2.9
TSS	4	2.8	1.5	1.0	4.0
CHL_A	4	9.1	6.9	1.8	17.8
TTL_HRDN	4	35.5	3.0	32.0	38.0
CA_HRDN	4	23.5	4.7	20.0	30.0
PPTH_ALK	4	0.0	0.0	0.0	0.0
MO_ALK	4	38.8	13.8	25.0	55.0

FIGURE 7

PLOT OF CHLOROPHYLL A AND SECCHI DEPTH VS TIME - LAKE FENWICK



Comparison with Pre-construction Conditions

When comparing the data, it is important to remember that while the sampling scheme was the same, the two monitoring periods were different. The pre-construction monitoring occurred from late-May through December (1979) while the post construction monitoring period was from January through November (1981). Therefore, a general comparison will be made keeping in mind that some differences could be caused by the different sampling periods.

Nutrients - A comparison of pre-construction (1979) and post-construction (1981) physical and chemical data is presented in Table 8. Values shown are seasonally-averaged data for surface (0.3 m) and bottom (6.1 m) water.

Throughout the year water temperature and pH were lower after construction at all depths. Conductivity was also lower at all depths except at the surface during stratification. Post-construction values of dissolved oxygen were higher in the upper 3 meters of the water column and lower or approximately equal in the lower part of the water column during both seasons.

There is no apparent difference in the total phosphorous concentrations between monitoring periods after turnover. During stratification 1981 mean TP-P values are higher in the surface

TABLE 8

STATISTICS FOR PARAMETERS FROM DISCRETE DEPTHS
IN WATER COLUMN DURING STRATIFICATION AND AFTER TURNOVER

DURING STRATIFICATION

	Pre-Construction (May - September)		Post Construction (March-September)	
Variable	Mean	Standard Deviation	Mean	Standard Deviation
		Depth = 0.3 m		
W-TEMP-C	21.49	1.955	18.408	4.009
D=0	7.86	0.811	9.070	0.932
COND	96.43	4.614	101.333	46.220
pH	7.54	0.181	6.950	0.118
TP-P	0.019	0.009	0.032	0.055
OP-P	0.006	0.002	0.003	0.001
NO_3NO_2-N	0.010	0.000	0.018	0.037
NH_3-N^2	0.022	0.040	0.011	0.005
TKN-N	0.305	0.072	0.441	0.117
		Depth = 6.1m		
W-TEMP-C	9.387	1.737	7.910	0.989
D-O	0.125	0.089	0.200	0.275
COND	93.286	12.698	83.778	33.022
pH	6.614	0.069	6.490	0.191
TP-P	0.133	0.113	0.094	0.035
OP-P	0.008	0.003	0.039	0.025
NO_3NO_2-N	0.010	0.000	0.028	0.033
NH_3-N^2	0.148	0.121	0.141	0.111
TKN-N	0.876	0.299	0.643	0.151

TABLE 8 - CONTINUED

AFTER TURNOVER

Variable	Pre-Construction (October - December) Mean	Pre-Construction (October - December) Standard Deviation	Post Construction (October - February) Mean	Post Construction (October - February) Standard Deviation
		Depth = 0.3 m		
W-TEMP-C	9.633	4.259	9.825	4.404
D-O	6.600	1.253	6.925	1.721
COND	75.667	18.475	62.750	17.877
pH	7.900	0.100	6.950	0.387
TP-P	0.023	0.008	0.030	0.012
OP-P	0.005	0.000	0.010	0.007
NO_3NO_2-N	0.041	0.032	0.159	0.170
NH_3-N	0.059	0.032	0.039	0.037
TKN-N	0.297	0.086	0.477	0.045
		Depth = 6.1m		
W-TEMP-C	9.200	3.676	7.982	2.687
D-O	6.233	1.002	2.675	2.403
COND	78.667	10.017	68.500	20.567
pH	7.467	0.058	6.800	0.497
TP-P	0.046	0.031	0.045	0.010
OP-P	0.005	0.001	0.008	0.003
NO_3NO_2-N	0.037	0.026	0.147	0.164
NH_3-N	0.125	0.110	0.083	0.053
TKN-N	0.473	0.310	0.567	0.105

and lower in the bottom waters than 1979 values. However, since the standard deviations for some of these values are quite large, the differences in mean values may not be significant.

Orthophosphate values are approximately the same or slightly higher in 1981 after turnover. During stratification OP-P values were at or below detection limits in the surface waters in both monitoring periods. At the same time OP-P values have increased in 1981 in the bottom waters.

Nitrate plus nitrite values are higher in 1981 at all depths and during both seasons. In 1979 all NO_3NO_2-N values were at or below the detection limit. Ammonia values were lower at all depths and during both seasons in 1981. However, some ammonia values had large standard deviations indicating that the differences may not be significant. After turnover total Kjeldahl nitrogen was higher at all depths in 1981. During stratification TKN-N was higher in the upper 4 meters and lower below 4 meters.

Generally, it appears that in-lake nutrient levels have not changed appreciably since 1979. Overall mean values of TP-P were .041 and .043 mg/l P in 1979 and 1981 respectively. Mean values of TKN-N were .418 and .489 mg/l N in 1979 and 1981 respectively. This difference is probably not significant considering the variability in TKN measurements.

Biological Conditions - There are many factors which affect phytoplankton and zooplankton standing stock. Physical factors include light intensity, temperature, stratification and mixing. These factors cause spatial patchiness in plankton standing stock and temporal variability on time scales of weeks, seasons and years. This natural variability makes it difficult to compare two years of data. An indication of the differences in the two years is provided by field notes on weather, air temperature and numbers of people using the lake. Table 9 lists the weather, air temperature, and number of swimmers for the May, June, July and August monitoring trips.

TABLE 9

COMPARISON OF WEATHER CONDITIONS
DURING 1979 AND 1981 MONITORING TRIPS

Monitoring Trip	1979 Weather		1981 Weather		Swimmers 1979	Swimmers 1981
May - end	Sunny	65°	Sunny	75°	12	0
June - mid	Sunny, breezy	82°	Heavy Rain	62°	2	0
June - end	Partly cloudy	—	Sunny	78°	2	0
July - mid	Sunny	90°	Cloudy	65°	43	0
July - end	Sunny	80°	Light Rain	63°	25	0
Aug. - mid	Sunny	75°	Sunny	90°	32	40
Aug. - end	Cloudy	65°	Sunny	65°	0	6

A comparison of the average numbers of zooplankton and phytoplankton per trip during similar periods of 1979 and 1981 is presented in Table 10.

The average number of zooplankton per sample decreased 16 percent. The average total cell volume of phytoplankton per trip decreased 20 percent. Chlorophyll *a* increased 11 percent. These differences could easily be accounted for by differences in weather.

TABLE 10

COMPARISON OF BIOLOGICAL CONDITIONS IN PRE AND POST CONSTRUCTION MONITORING PERIODS

Zooplankton Averages

Taxa	5/31/79-11/14/79	5/28/81-11/04/81	% Change
Cladocer	5.6	1.2	-79
Copepoda	41.2	6.3	-85
Rotifera	85.9	104.2	+21
Diptera	1.2	0.4	-67
Total	134	112	-16

Phytoplankton Averages

Taxanomic Division	5/31/79-11/14/79	5/28/81-11/04/81	% Change
Cyanophyceae	0.569	0.612	+ 8
Chrysophyceae	0.157	0.088	-44
Cryptophyceae	0.494	0.121	-76
Diatoms	0.232	0.364	+57
Total Cell Volume	1.876	1.504	-20
Chl *a*	9.0	10.0	+11

STORMWATER MONITORING/POND

Three storms were sampled, one each in July, November and December 1981. The hydrographs from each storm and the collection times of the samples analyzed are shown in Figures 8, 9, 10, and 11. Stormwater data is listed in Appendix C.

The July 13 storm is characterized by one peak in the hydrograph caused by heavy rains with 0.68 inches in a 10-hour period. Peak stormwater flows into and out of the pond were 9.64 cfs and 5.34 cfs respectively. The November 11 storm appears as two tall narrow peaks in the hydrograph caused by 0.85 inches of rain in a 20-hour period with 0.35 inches falling in one hour. Peak stormwater flows into and out of the pond were 21.1 cfs and 21.8 cfs respectively. The December 2 storm appears as two short broad peaks caused by a light steady rain falling over an 18-hour period. Peak stormwater flows were 4.76 cfs and 2.44 cfs into and out of the sedimentation pond.

Nutrients and TSS

The results of the nutrient and suspended solids analyses of stormwater samples are shown in Table 11. Each sample listed was a composite of 2 to 4 individual one liter samples (Figures 8, 9, 10). The discharge volume (Q-VOL) shown is the amount of water (m^3) flowing in or out of the pond, represented by each sample. The sum of all Q-VOL at a station for each storm

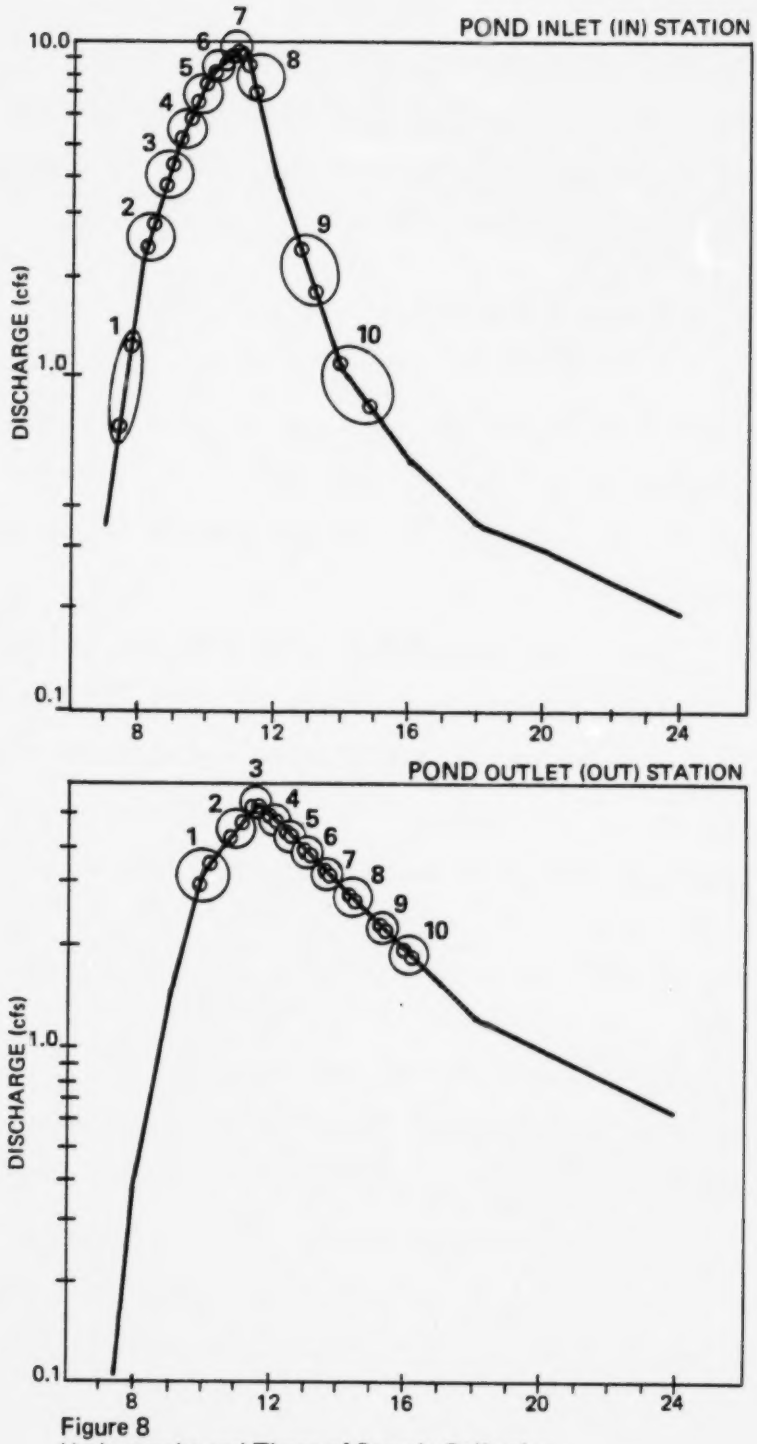


Figure 8
Hydrographs and Times of Sample Collection
for the July 13, 1981 Storm

O Marks Times of Individual Samples
◯ Indicates Composite Samples

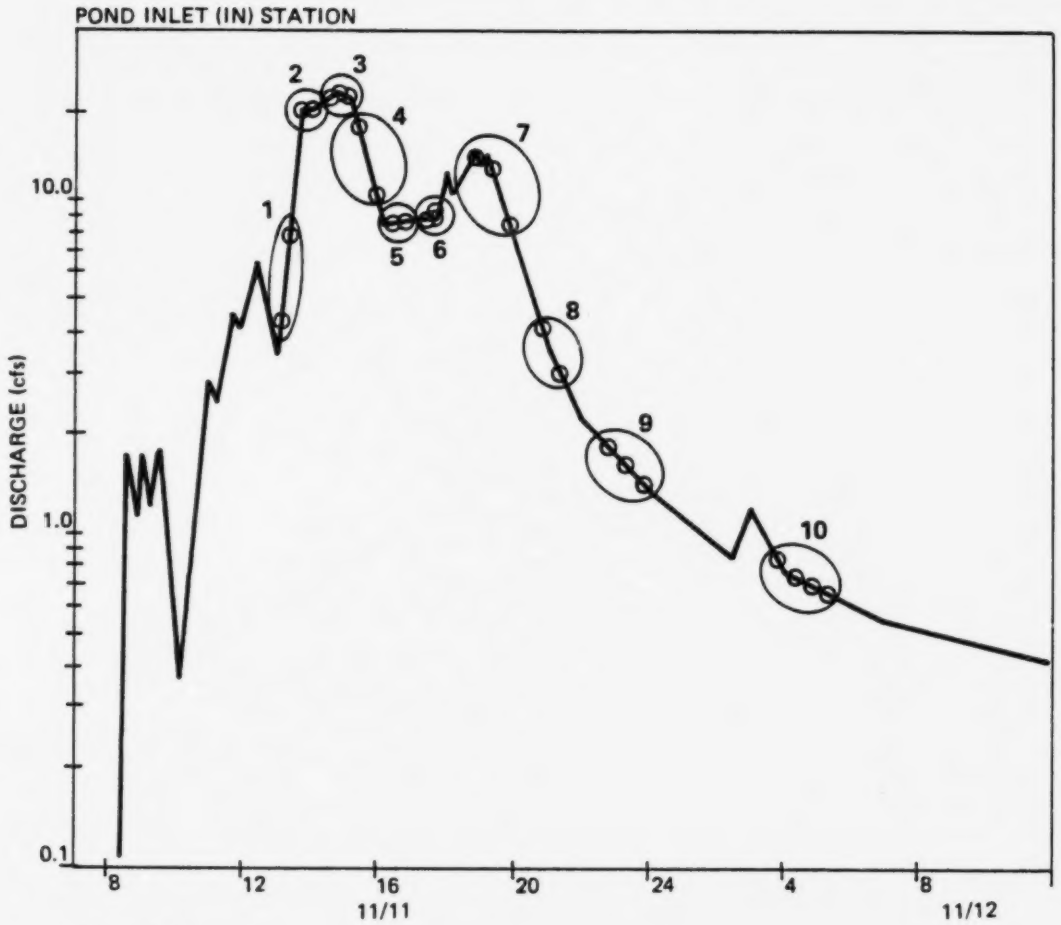


Figure 9
Hydrographs and Times of Sample Collections
for the November 11-12, 1981 Storm

O Marks Times of Individual Samples
◯ Indicates Composite Samples

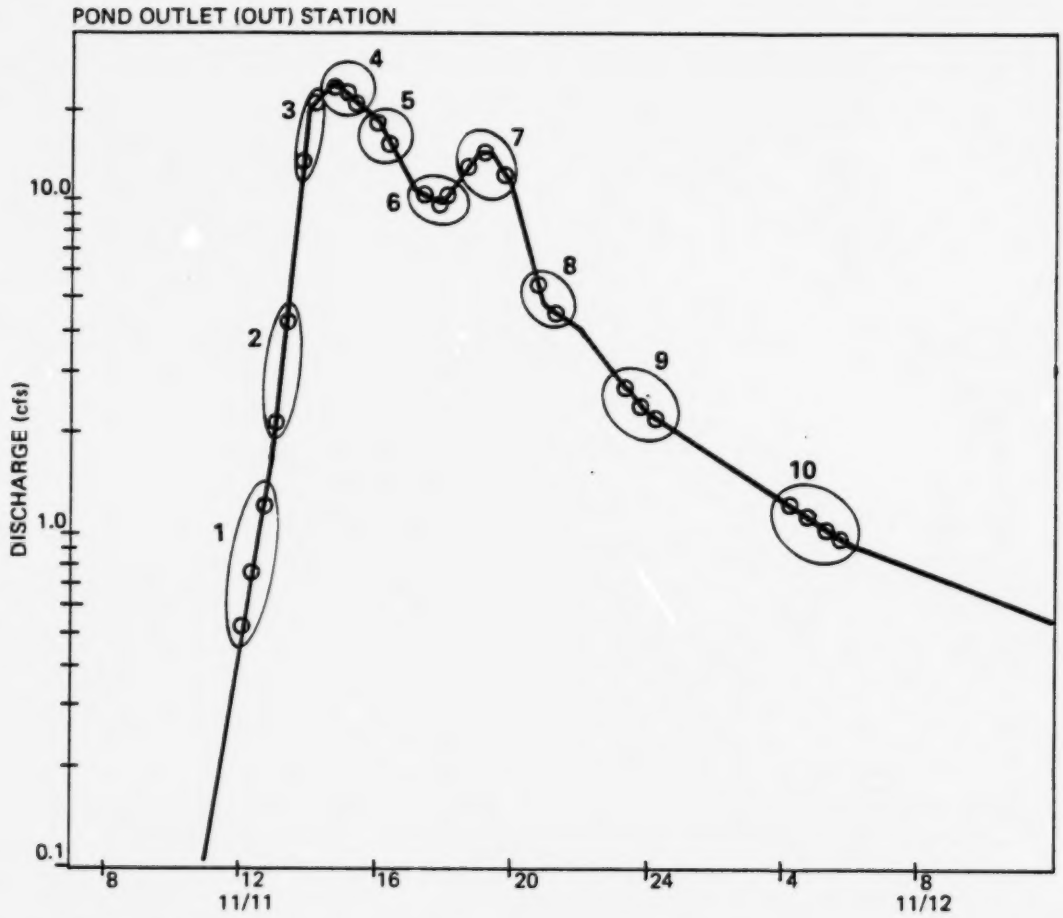


Figure 10
Hydrographs and Times of Sample
Collections for the November 11-12, 1981 Storm

O Marks Times of Individual Samples
◯ Indicates Composite Samples

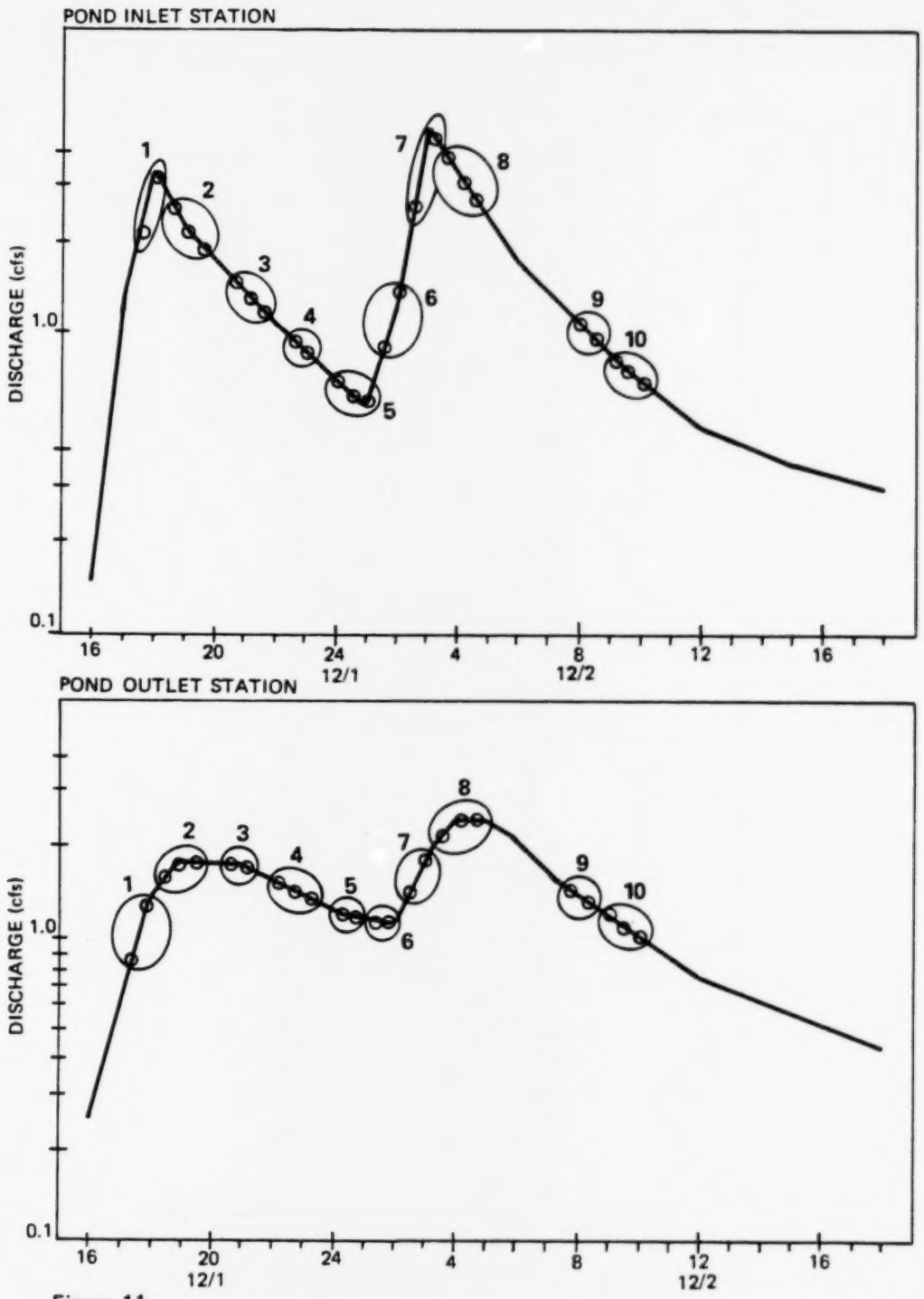


Figure 11
Hydrographs and Times of Sample Collection
for the December 1-2,1981 Storm

○ Marks Times of Individual Samples
◯ Indicates Composite Samples

TABLE 11

POLLUTANT MASS IN KILOGRAMS

OBS	MM	DAY	YR	STATION	SAMPLE	Q_VOL	TP_M	TDP_M	TN_M	TIN_M	TSS_M
1	12	2	81	IN	1	380.83	0.031228	.	0.19384	0.07769	3.047
2	12	2	81	IN	2	416.89	0.034185	.	0.18301	0.05586	3.752
3	12	2	81	IN	3	276.09	0.014633	.	0.18277	0.07648	1.104
4	12	2	81	IN	4	139.87	0.004450	.	0.10931	0.03630	0.278
5	12	2	81	IN	5	119.71	0.004908	.	0.15299	0.03627	0.479
6	12	2	81	IN	6	179.82	0.005215	.	0.14871	0.06330	0.539
7	12	2	81	IN	7	333.54	0.013675	.	0.15610	0.06437	3.335
8	12	2	81	IN	8	776.33	0.036487	.	0.72664	0.36565	6.211
9	12	2	81	IN	9	365.38	0.015711	.	0.41580	0.16186	1.096
10	12	2	81	IN	10	228.72	0.009835	.	0.26577	0.13883	0.686
11	12	2	81	OUT	1	169.74	0.008487	0.000849	0.20132	0.11729	1.018
12	12	2	81	OUT	2	307.68	0.016922	0.001538	0.45844	0.17845	2.461
13	12	2	81	OUT	3	336.20	0.018155	0.001681	0.26560	0.15163	2.690
14	12	2	81	OUT	4	215.99	0.011447	0.001080	0.24320	0.10907	2.160
15	12	2	81	OUT	5	185.42	0.009457	0.002410	0.24253	0.09549	1.669
16	12	2	81	OUT	6	146.62	0.008064	0.000733	0.13849	0.07082	1.026
17	12	2	81	OUT	7	168.87	0.006417	0.000844	0.17123	0.09794	1.182
18	12	2	81	OUT	8	652.54	0.043068	0.007178	0.62644	0.37978	5.220
19	12	2	81	OUT	9	431.66	0.042734	0.032374	0.34964	0.16187	3.022
20	12	2	81	OUT	10	339.97	0.019718	0.002380	0.23458	0.13327	2.040
21	11	11	81	IN	1	1866.44	0.405018	0.055993	1.59207	0.25944	175.446
22	11	11	81	IN	2	741.69	0.253657	0.052660	0.93452	0.21888	120.153
23	11	11	81	IN	3	2595.79	0.843631	0.134981	3.55623	1.25117	244.804
24	11	11	81	IN	4	863.12	0.228727	0.057829	1.07898	0.47731	47.472
25	11	11	81	IN	5	988.24	0.239153	0.050400	1.18588	0.51191	56.329
26	11	11	81	IN	6	1388.43	0.319338	0.083386	1.77719	0.79696	73.587
27	11	11	81	IN	7	2026.99	0.297967	0.093241	2.43238	1.29119	44.594
28	11	11	81	IN	8	707.44	0.082063	0.029005	1.09654	0.64519	8.489
29	11	11	81	IN	9	553.72	0.063124	0.014950	1.53380	0.78074	6.091
30	11	11	81	IN	10	457.44	0.042085	0.014638	1.19392	0.56951	4.117
31	11	11	81	OUT	1	156.90	0.016003	0.006903	0.23064	0.07390	2.040
32	11	11	81	OUT	2	599.82	0.083375	0.002999	0.66580	0.12236	14.995
33	11	11	81	OUT	3	889.41	0.109398	0.006226	0.83605	0.20723	30.240
34	11	11	81	OUT	4	2105.10	0.423124	0.048417	1.85248	0.38734	141.041
35	11	11	81	OUT	5	2256.92	0.548433	0.097048	2.46805	0.90728	157.985
36	11	11	81	OUT	6	1573.54	0.338310	0.061368	1.82530	0.82453	80.250
37	11	11	81	OUT	7	2252.37	0.448221	0.085598	2.86051	1.36719	99.104
38	11	11	81	OUT	8	1251.37	0.208979	0.050055	1.51416	0.65572	35.038
39	11	11	81	OUT	9	1017.27	0.152591	0.041708	1.45478	0.62867	22.380
40	11	11	81	OUT	10	620.05	0.083087	0.018602	1.04169	0.65168	9.921
41	7	13	81	IN	1	130.41	0.028689	0.006912	0.20265	0.07303	5.738
42	7	13	81	IN	2	144.92	0.033188	0.013623	0.18304	0.06478	6.377
43	7	13	81	IN	3	209.87	0.043444	0.022247	0.30725	0.08815	8.185
44	7	13	81	IN	4	282.21	0.060957	0.026528	0.31966	0.09821	10.442
45	7	13	81	IN	5	361.93	0.076005	0.037641	0.45024	0.12450	24.249
46	7	13	81	IN	6	424.22	0.101812	0.051754	0.58287	0.17817	11.878
47	7	13	81	IN	7	468.98	0.093781	0.043139	0.74696	0.25837	9.378
48	7	13	81	IN	8	758.38	0.169119	0.071288	1.15274	0.46118	21.235
49	7	13	81	IN	9	311.36	0.053242	0.020238	0.62271	0.27244	4.048
50	7	13	81	IN	10	320.67	0.044252	0.014751	0.71829	0.39153	2.245
51	7	13	81	OUT	1	553.72	0.094132	0.006645	1.00832	0.13178	8.306
52	7	13	81	OUT	2	313.98	0.064350	0.001578	0.70691	0.08578	5.964
53	7	13	81	OUT	3	295.51	0.058215	0.001478	0.48434	0.07358	5.910
54	7	13	81	OUT	4	291.21	0.055621	0.001456	0.48282	0.07484	5.824
55	7	13	81	OUT	5	223.12	0.036368	0.001116	0.32798	0.05355	4.016
56	7	13	81	OUT	6	198.67	0.033972	0.001391	0.31131	0.05463	3.377
57	7	13	81	OUT	7	257.41	0.048394	0.002316	0.31816	0.07387	3.861
58	7	13	81	OUT	8	228.86	0.042110	0.001602	0.34970	0.06637	3.204
59	7	13	81	OUT	9	168.04	0.037642	0.000840	0.27223	0.04503	2.688
60	7	13	81	OUT	10	413.12	0.078906	0.004131	0.63331	0.12352	5.783

equals the total amount of water passing that station from the beginning of the storm until approximately 2 hours after the last sample was taken. In all cases the last sample was taken after rain had stopped and after the hydrograph had started to become flat.

July Storm - The amounts of total phosphorus (TP) and orthophosphate (TOP) retained in the pond were 0.155 and 0.283 kg respectively. This is equivalent to 22 and 93 percent of the incoming amounts. The amounts of total nitrogen (TN) and total inorganic nitrogen (TIN) retained were 0.391 kg (7%) and 1.227 kg (61%) respectively. The total suspended solids (TSS) retained was 58 kg or 56 percent of the incoming amount.

Orthophosphate and total inorganic nitrogen are determined from filtered samples so the quantities are not retained in the pond by settling out with particles.

Therefore, it would seem unreasonable that more orthophosphate would be retained than total phosphorus and that more inorganic nitrogen would be retained than total nitrogen.

One possible explanation for this is that much of the outlet stream was displaced pond water, and that much of the input of TOP and TIN went into raising the concentration of these quantities in the pond. The concentrations of nutrients and solids in the pond at the start of the storm are not known. The outlet from the pond was sampled 18 days prior to the storm. At that time,

concentrations of OP and TIN were <.005 mg/l P and 0.212 mg/l N respectively. The first few outlet samples had concentrations with only slightly higher values. The total amount of water discharged into the pond was equivalent to approximately 80 percent of the pond volume. Therefore, although the data does not exist to prove this explanation, it seems reasonable that the large quantities of filterable orthophosphate and inorganic nitrogen retained in the pond went into raising the concentration of the pond water.

November Storm. The amounts of total phosphorus and orthophosphate retained in the pond were .363 kg and .168 kg respectively, equivalent to 13 and 29 percent of incoming amounts. Nitrogen removal equalled 1.640 kg TN and 0.977 kg TIN or 10 and 14 percent respectively. Twenty-four percent or 187 kg of the total suspended solids were retained in the sedimentation pond. This storm was very similar to one sampled in the pre-construction monitoring period. A comparison of these storms is presented later in this report.

December Storm. During the December storm, output of nutrients and TSS exceeded inputs by small amounts. These excess amounts were as follows: 0.014 kg TP, 0.288 kg TN, 0.419 kg TIN and 2.0 kg TSS. The total amounts of incoming nutrients and sediments were very small relative to the other storms. Incoming TSS

was 20.5 kg compared with 104 kg and 780 kg for the July and November storms respectively. The highest concentration of TSS measured for an inlet sample was 10 mg/l compared with 67 mg/l and 162 mg/l for the July and November storms.

This was a relatively small storm which occurred during a wet period. Therefore, the pond already contained a significant amount of stormwater. Also the streets in the watershed were probably cleaner due to the previous washoff. Concentrations of nutrients and TSS in the pond may have been very similar to concentrations in the inlet samples. The differences listed above could easily be accounted for by uncertainties in the discharge measurements and possible high concentrations of pond water.

Comparison of Similar Pre and Post Construction Storms

During the initial phase of lake monitoring, two storms were sampled. The December 1, 1979 storm was similar in size and duration to the November 11, 1981 storm. The December 1, 1979 storm was characterized by 1 inch of rain, 21 hours' duration, peak flows of 13.5 cfs and total discharge of 12692 m^3. The November 11, 1981 storm was characterized by 22 hours' duration, 0.85 inches of rain, peak flows of 21.1 cfs and total discharge of 12722 m^3.

The nutrient and suspended solids loads to the lake from these storms are presented in Table 12. Total phosphorus and orthophosphate loads were reduced by 68 and 34 percent respectively. Total nitrogen and total inorganic nitrogen loads were reduced by 36 and 7 percent respectively. Total suspended solids were reduced by 78 percent.

TABLE 12

NUTRIENT AND SUSPENDED SOLIDS
LOADS TO THE LAKE FROM TWO STORMS

Mass in Kilograms

Variable	12/01/79	11/11/81	% decrease
TP	7.476	2.412	68
TOP	0.631	0.419	34
TN	23.044	14.741	36
TIN	6.238	5.825	7
TSS	2695	593	78
Q-VOL	12692	12722	

The 78 percent decrease in suspended sediment discharge into the lake indicates that the sedimentation pond/diversion pipe system is working as designed. Approximately 90 percent of the total decrease in suspended sediment discharge is due to the diversion pipe and elimination of ravine erosion. The other 10 percent is due to retention of particles in the sedimentation pond.

The input of total solids to the lake includes bedload and suspended load discharges. Bedload discharge was primarily

due to ravine erosion and could not be measured with the stormwater samplers. Input due to bedload transport has been virtually eliminated. Therefore, the reduction in total sediment discharge would be some unknown amount greater than 78 percent.

STORMWATER MONITORING/LAKE

Within a day following each storm the lake was sampled at five stations for nutrients, total suspended solids and secchi depth. Raw data is listed in Appendix C. The TSS and secchi depth data are summarized in Figure 12 and Table 13. Surface samples were collected at 0.3 m. Deep samples were collected at 10 m in the northwest bay (stations L5, L4, L3) and at 2.4 m at stations L2 and L1.

During July and December storms, secchi depths in the bay were to the bottom. At stations L2 and L1 secchi depths ranged from 2.1 to 3 m typical of depths measured during routine lake monitoring. During the July and December storms TSS concentrations ranged from 1 mg/l to 3 mg/l at the surface and 2 mg/l to 10 mg/l at depth. Surface concentrations were typical of values measured at L1 during routine monitoring. Deep values were larger but were still relatively low.

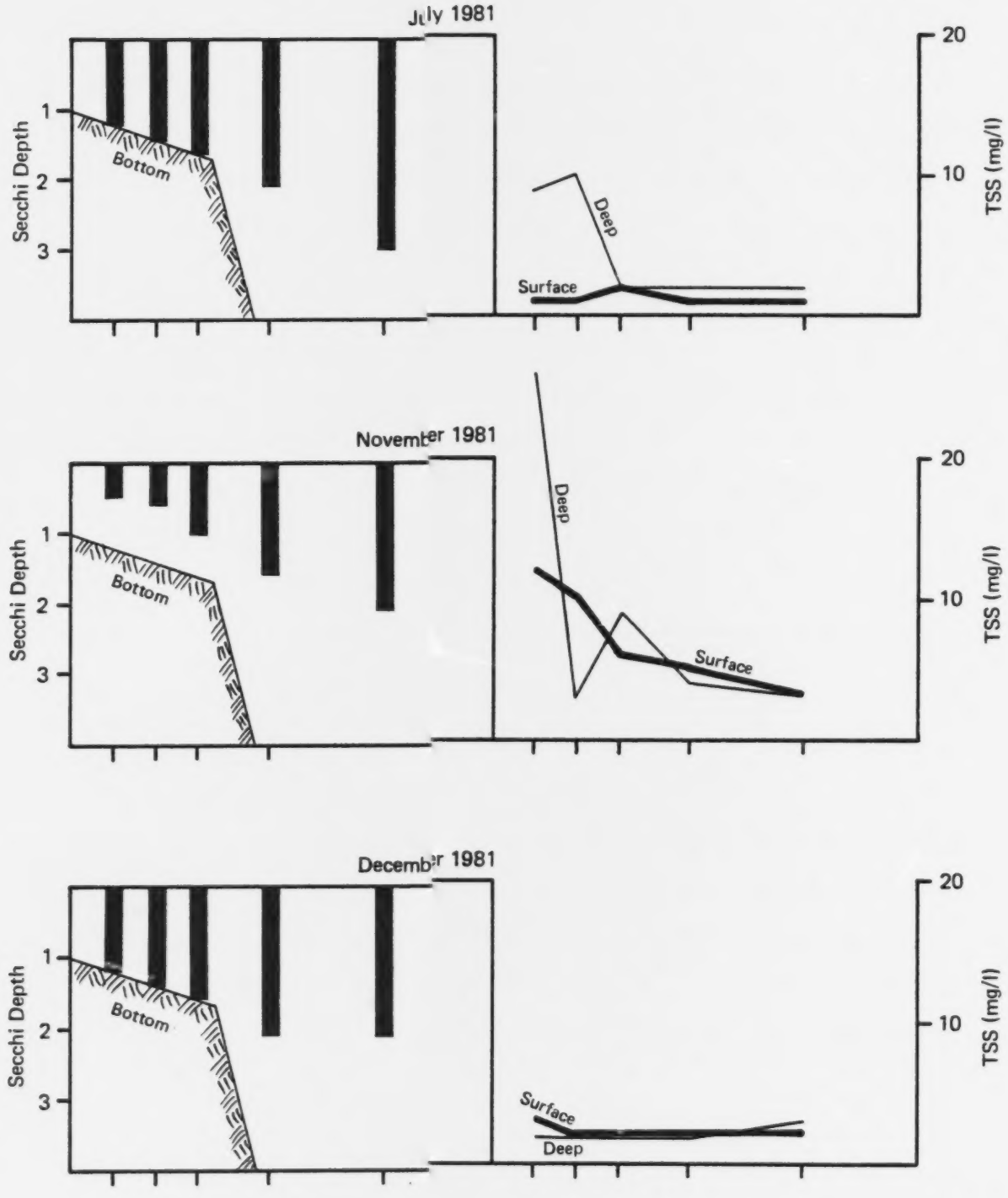


Figure 12
Secchi Depths and TSS Measured in the Lake Following Each Storm

TABLE 13

SECCHI DEPTHS AND TSS OBSERVED IN LAKE FENWICK FOLLOWING STORMS

Station		July		November		December	
		Secchi Depth (m)	TSS (mg/l)	Secchi Depth (m)	TSS (mg/l)	Secchi Depth (m)	TSS (mg/l)
L5	0.3	1.2	1	0.5	12	1.2	3
	1.0		9		26		2
L4	0.3	1.4	1	0.6	10	1.4	2
	1.0		10		3		2
L3	0.3	1.6	2	1.0	6	1.6	2
	1.0		2		9		
L2	0.3	2.1	1	1.6	5	2.1	2
	2.4		2		4		2
fL1	0.3	3	1	2.1	3	2.1	2
	2.4		2		3		3

During the pre-construction stormwater monitoring the lake was sampled once after a storm on October 23, 1979 with 0.78 inches of rain. At that time secchi depths in the bay ranged from 0.3 to 0.6 m. Suspended solids of 12 mg/l to 106 mg/l were also measured. After the November 1981 storm, secchi depths of 0.5 m to 1.0 m were measured. Suspended solids ranged from 6 to 12 mg/l at the surface and 3 to 26 mg/l at 1 m. No visible plumes of sediments were observed in or exiting the bay. Plumes had been observed during 1979 monitoring.

During small storms such as the July and December storms, it could be expected that no obvious effects of stormwater

runoff will be observed in the lake. During large storms such as the November storm, some stormwater effects will be visible. However, these will be much less severe than those observed during the pre-construction monitoring. Sampling in the lake following the storms is further evidence that the diversion pipe/sedimentation pond system does work as designed to reduce sediment discharge into Lake Fenwick.

PHOSPHORUS LOADING

The phosphorus loading to Lake Fenwick is calculated by estimating the contributions from four sources: the inlet stream, atmospheric inputs, sediment release and septic tank inputs.

Inlet Stream Input

The amount of total phosphorus brought into Lake Fenwick by the inlet stream was calculated using two methods described in Appendix D. One method used average monthly flow (including storms) combined with phosphorus concentrations from routine monitoring to estimate phosphorus loading. Stormwater has higher concentrations of nutrients so a correction was made to account for this. The other method used instantaneous flows and concentrations to establish a base flow. Stormwater contributions were calculated separately and added to the base flow.

The two methods produced very similar results. The one presented here is used because it is most like the method used previously to estimate loading (URS, 1980). Base flow inputs were 19.2 kg/yr. Stormwater flows contributed 18.3 kg/yr, yielding a total stream input of 37.5 kg/yr. Therefore stormwater inputs account for about one half of the inlet stream load. The majority of the stormwater load is contributed by a few large storms. For example, the November 11, 1981 storm which was monitored contributed 2.4 kg of phosphorus or 13 percent of the stormwater load. The October 6, 1981 storm which was a record storm for the King County area contributed an estimated 6.0 kg of phosphorus or 33 percent of the stormwater load.

Other Inputs

Loadings from atmospheric inputs, sediment release and septic tanks were estimated as described below. These are the same estimates used in the previous phosphorus loading calculations (URS, 1980).

Atmospheric loading was based on extrapolating a total phosphorus deposition rate of 2.2 ug/cm^2 -yr for precipitation and dryfall, as cited by Eisenreich et al. (1977) and Murphy and Doskey (1975). The areal loading rate is about four times higher than that estimated by Davis, et al. (1978) for Lake Meridian. However, the estimate of Davis, et al. (1978) was for precipitation only.

Sediment phosphorus release was based on the anaerobic release rate of 2.5 mg/m^2-day, as reported by McDonnell (1975). This rate is about two times higher than that estimated by Davis, et al. (1978) for Lake Meridian. However, the highest rate reported by McDonnell (1975) for anaerobic sediments was twice that used for the Lake Fenwick estimate.

Septic tank contributions were estimated using the per capita rate of 0.8 kg phosphorus by Sikora and Corey (1976) and Dillon and Rigler (1975).

The soils in the Lake Fenwick watershed have severe limitations for septic tanks and filter fields (US/SCS, 1973). Therefore, the soil retention rate for phosphorus was assumed to be 85 percent which is the same rate used by Davis, et al. (1978) for Lake Meridian.

Total Inputs

The total phosphorus loading from the four sources is summarized in Table 14. Other sources for which no estimates have been provided include groundwater, macrophyte decay, leaf litter and internal phosphorus cycling.

TABLE 14

ESTIMATED TOTAL PHOSPHORUS LOADING
TO LAKE FENWICK - POST-CONSTRUCTION

Source	Estimated Annual Load (Kg/yr)	Percent of Total
Inlet Stream	37.5	60
Atmospheric	2.0	3
Sediment Release	13.5	22
Septic Tanks	9.0	15
Total	62	100

Comparison with Pre-Construction Loading Estimate

The Lake Fenwick Restoration Workplan presented an estimate of phosphorus loading of the 27 kg/yr from the inlet stream. A comparison of inlet stream loading estimates from the two monitoring periods is presented in Table 15.

TABLE 15

COMPARISON OF PHOSPHORUS LOADING
ESTIMATES FROM TWO MONITORING PERIODS

	5/79-12/79	Annual 1979	Annual 1981
Base Flow	0.48	.93	19.15
Stormwater	13.52	26.07	18.32
Total	14.0	27.0	37.47

During the pre-construction monitoring the stormwater contribution was based on estimates of storm frequency determined from rainfall reported at Sea-Tac. It was stated in that report that stormwater contribution was probably an underestimate of the actual amount.

Base flows measured this year were approximately 30 times larger than flows measured during the 1979 monitoring. This accounted for the large difference in base flow contribution. Before the inlet stream was diverted into the pond, stream flow into the lake was much more variable. It appears that during the 1979 monitoring the instantaneous flow measurements were untypically low. Low flow values yielded under estimates of base flow contributions.

By storing water, the pond acts as a filter to smooth out flow fluctuations producing more uniform discharge. Water from even small storms is discharged over a longer period of time. The many small rainfalls which occur and are not calculated as storms are thus included as base flow.

It will be assumed that the difference in baseflow contributions is an artifact of different systems and different sampling periods.

Therefore, the real difference in loading is due to stormwater contributions. A decrease of approximately 8 kg/yr. or 30 percent is indicated assuming the two estimates are correct. The comparison of two similar storms showed a 68 percent decrease in phosphorus loading. Considering the uncertainty involved in the estimates, this could be considered fairly good agreement.

The comparison of phosphorus loading estimates indicates that the diversion pipe/retention pond system has reduced the stormwater contribution by 30 percent and the total contribution by 17 percent.

TOTAL SUSPENDED SOLIDS LOADING

The total suspended solids loading to Lake Fenwick was calculated using the two methods described in the previous section and in Appendix D. The loading estimate is presented in Table 16 along with TSS loadings estimated from the 1979 monitoring data.

TABLE 16

ESTIMATES OF TSS LOADINGS

	1979 Annual Kg/Yr.	%	1981 Annual Kg./Yr.	%
Base Flow	225	<1	1339	25
Stormwater	10225	100	4039	75
Total	10450	100	5378	100

It will be assumed here, as it was in the phosphorus loading calculations, that differences in baseflow contributions are due to differences in the drainage system and sampling periods. The 1981 baseflow estimate does have some stormwater effects included. Two of the routine sampling trips occurred 2 days after fairly heavy rains resulting in higher than normal TSS concentrations. Therefore, the percent contribution of stormwater loading may be more than that calculated.

The estimates listed in Table 16 indicate a 60 percent reduction in stormwater loading of TSS. The comparison of two similar storms showed a 78 percent reduction. These numbers are in fairly good agreement considering the assumptions made to arrive at each.

TROPIC STATE

The trophic state of Lake Fenwick was estimated by comparing several parameters to suggested criteria as done by Davis et al. (1978). Table 17 lists the criteria and measured values for Lake Fenwick and five other western Washington Lakes. For Lake Fenwick, values for both the preconstruction (1979) and post-construction (1981) monitoring periods are shown.

Of the five lakes shown, Lake Fenwick compares closest to Lake Sammamish and by this approach appears to be mestrophic to eutrophic. Two of the five 1981 values, phytoplankton and

TABLE 17
TROPHIC STATE INDICATORS FOR LAKE FENWICK AND OTHER WESTERN WASHINGTON LAKES
(Adapted from Davis, et al., 1978)

	Suggested Criteria	Lake Washington	Lake Sammamish	Chester Morris Lake	Findlay Lake	Lake Meridian	Lake Fenwick (a)	Lake Fenwick (b)
Phytoplankton maximum density reported -cm^3/m^3	<1,0[3] >10,E[4]					5	4.6	3.3
Chlorophyll a mean summer epilimnetic - ug/l	0-4,0 10-100,E	4.0[5]	7[10]	1.4[9]	.88[9]	2.9[6]	9.8[12]	12.4[13]
Secchi disk meters	5- 3,0 2-1.5,E	5.7[5]	3.5[9]	7.7[9]	13[9]	5.2	3.4[14] (1.8)	2.7[14] (2.2)
P_{TOTAL} concentration winter or post-overturn - ug/l	10-15,0 20-30,E	13.4	30	12	6.7		26	39
N_{TOTAL} concentration winter or post-overturn - ug/l	300,E		180			94[7]	406[15] (113)	633[15] (21)

a. pre-construction (1979) data
b. post-construction (1981) data
1. criterial from Vollenweider (1968)
2. criterial from EPA Water Criteria (1973)
3. oligotrophic
4. eutrophic
5. 1976 data (T. W. Edmonson)
7. combined inorganic N
8. 1976 annual mean (T.W. Edmonson)
9. data from Birch (1976)
10. data from Welch et al. (1975)
11. annual mean epilimnetic NO_2+NO_3 from Welch et al. (1975)
12. euphotic zone composite mean May-Sept, 1979 before overturn
13. euphotic zone composite mean, Mar-Sept, 1981 before overturn
14. Mean during stratification; (Mean) after turnover
15. TKN-N+NO3-NO2-N; (NO3-NO2-N + NH3-N) after turnover

and secchi depth, are in the mesotrophic range. Chlorophyll a, and nitrogen concentrations are in the eutrophic range.

Comparing 1979 and 1981 values for the trophic state indicators it appears that Lake Fenwick is becoming more eutrophic. Except for phytoplankton cell volume all 1981 measurements trended toward more eutrophic values.

SUMMARY AND CONCLUSIONS

The post-construction monitoring plan consisted of two parts: routine lake monitoring and stormwater monitoring. The stormwater monitoring consisted of sampling the inlet and outlet of the retention pond and sampling the lake after each storm.

Routine lake monitoring measured mean annual values of total phosphorus and total nitrogen of 0.043 and 0.489 mg/l respectively. It appears that in-lake nutrient levels have not changed significantly since 1979 when the TP and TN values were 0.041 mg/l and 0.418 mg/l respectively. However, average values of TP after turnover have increased since 1979. The increased lake concentrations of TP, TN and chlorophyll a indicate a trend toward becoming more eutrophic.

The lake is still dominated by blue-green algae in the summer. Dominant species have been associated with taste and odor problems. Some are generally considered polluted water algae.

A comparison of similar storms sampled during pre and post construction monitoring periods showed reductions in nutrient and TSS discharges into the lake. Total phosphorus was reduced by 68 percent and suspended solids were reduced by 78 percent. Ninety percent of the TSS decrease was due to the diversion pipe while the remaining 10 percent was due to retention in the pond.

Phosphorus loading estimates showed that approximately half of the inlet stream load was contained in baseflow and half was contributed by stormwater flows. A comparison of phosphorus loading estimates showed a 30 percent reduction in stormwater contributions. This is a decrease of approximately 17 percent of the total phosphorus load.

Total suspended solids estimates showed that approximately 75 percent of the inlet stream load was contributed by stormwater. A comparison of TSS loading estimates showed a 60 percent decrease in stormwater loads.

The two methods used to calculate the reductions in stormwater contributions of phosphorus and suspended solids produced somewhat different results. The comparison of similar storms indicated larger reductions than the comparison of loading estimates. The two methods provide the ranges described below for the reductions of phosphorus and suspended solids inputs into Lake Fenwick.

Stormwater phosphorus loads have been reduced approximately 30 to 70 percent. This is equivalent to an overall phosphorus reduction of 17 to 40 percent. Stormwater TSS loads have been reduced by approximately 60 to 80 percent. This is equivalent to an overall reduction of 54 to 70 percent.

The diversion pipe/sedimentation pond system was designed to reduce total and suspended solids inputs to Lake Fenwick. The real indicator of its efficiency is the condition of the northwest bay following a storm. In two of the three storms monitored there was virtually no indications of stormwater. After the November storm some turbidity was apparent. However there was no visible plume of sediment as there had been previous to construction. Also TSS concentrations were significantly lower than 1979 concentrations following a storm.

The post-construction stormwater sampling shows that the diversion pipe/sedimentation pond is working to reduce the suspended solids load to Lake Fenwick.

CHAPTER 4

RECOMMENDATIONS

The Lake Fenwick Restoration Work plan made two major recommendations:

- the recommended plan addressing the sedimentation/ stormwater conditions in Lake Fenwick should proceed
- steps should be taken to implement a further study of in-lake biological/nutrient conditions and alternative in-lake restoration techniques.

The first recommendation was implemented. The sedimentation pond system is working as designed to reduce total suspended solids discharge into the lake. The question now is: Is further study of in-lake biological nutrient conditions and an evaluation of alternative in-lake restoration techniques needed?

Post-construction monitoring produced two results which appear to be conflicting. These are that nutrient levels and biological conditions appear to be unchanged or increased since 1979 and that a reduction in stormwater phosphorus loading has occurred. There are two possible explanations for this:

- there is a lag time between the reduction of phosphorus input and the lowering of lake concentrations and improved biological conditions
- the reduction in stormwater loading has been offset by other inputs such as an increase in release of phosphorus from the lake sediments

Nevertheless the monitoring results do indicate a present or potential water quality problem with respect to nutrients and algal growth. As further development occurs within the watershed, the input of nutrients will likely increase.

However, the long-term effects of the recently installed sedimentation pond on nutrient loading and algal growth are uncertain.

Our recommendation at this time is that the lake be allowed to react to the measures already taken through the next growing season. The lake should be monitored visually throughout this period to determine whether algae-related water quality problems occur. If there are indications of additional water quality problems, the additional studies previously recommended should be performed.

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WATER COLUMN DATA

VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

OBS	MN	DAY	YR	STATION	DEPTH_M	W_TEMP_C	D_O	COND	PH	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N
1	1	14	81	L1	0.3	5.66	5.4	58	6.6	0.036	0.019	0.240	0.093	0.48
2	1	14	81	L1	1.2	5.66	5.2	58	6.6	0.027	0.012	0.272	0.083	0.48
3	1	14	81	L1	2.4	5.66	5.7	57	6.6	0.032	0.018	0.262	0.297	0.48
4	1	14	81	L1	3.7	5.66	5.5	56	6.6	0.031	0.012	0.241	0.103	0.36
5	1	14	81	L1	4.9	5.66	5.3	55	6.6	0.047	0.014	0.268	0.088	0.50
6	1	14	81	L1	6.1	5.62	4.9	55	6.5	0.034	0.012	0.242	0.110	0.45
7	2	23	81	L1	0.3	7.17	9.1	42	6.8	0.042	0.006	0.360	0.019	0.48
8	2	23	81	L1	1.2	7.12	9.1	55	6.8	0.041	0.006	0.340	0.019	0.40
9	2	23	81	L1	2.4	6.71	7.8	54	6.8	0.044	0.003	0.390	0.030	0.14
10	2	23	81	L1	3.7	6.42	7.1	52	6.7	0.049	0.003	0.260	0.037	0.22
11	2	23	81	L1	4.9	6.15	.	52	6.8	0.033	0.009	0.300	0.049	0.31
12	2	23	81	L1	6.1	5.71	4.5	52	6.8	0.040	0.006	0.330	0.079	0.53
13	3	27	81	L1	0.3	12.12	11.1	68	7.0	0.187	0.003	0.116	0.019	0.59
14	3	27	81	L1	1.2	12.10	11.0	68	7.1	0.052	0.003	0.092	0.021	0.53
15	3	27	81	L1	2.4	9.74	11.0	65	7.3	0.175	0.003	0.120	0.020	0.67
16	3	27	81	L1	3.7	7.30	3.8	60	7.0	0.031	0.003	0.186	0.016	0.50
17	3	27	81	L1	4.9	6.34	0.9	58	6.9	0.016	0.003	0.162	0.014	0.39
18	3	27	81	L1	6.1	5.99	0.2	58	6.7	0.059	0.003	0.110	0.115	0.48
19	4	28	81	L1	0.3	14.11	10.3	77	6.9	0.021	0.006	0.019	0.010	0.56
20	4	28	81	L1	1.2	14.09	10.2	75	6.9	0.028	0.003	0.012	0.003	0.39
21	4	28	81	L1	2.4	13.24	10.8	74	7.0	0.030	0.003	0.015	0.010	0.39
22	4	28	81	L1	3.7	9.91	6.3	69	7.0	0.024	0.007	0.026	0.007	0.30
23	4	28	81	L1	4.9	8.40	0.8	65	6.8	0.045	0.006	0.008	0.048	0.50
24	4	28	81	L1	6.1	7.14	0.1	66	6.6	0.089	0.035	0.008	0.254	0.59
25	5	12	81	L1	0.3	14.85	9.2	79	6.9	0.012	0.003	0.008	0.015	0.32
26	5	12	81	L1	1.2	14.94	9.1	78	7.0	0.023	0.005	0.008	0.026	0.62
27	5	12	81	L1	2.4	14.08	9.0	76	7.1	0.012	0.005	0.008	0.016	0.36
28	5	12	81	L1	3.7	10.81	8.6	71	7.1	0.032	0.005	0.008	0.016	0.28
29	5	12	81	L1	4.9	8.41	0.3	68	7.0	0.037	0.003	0.008	0.028	0.42
30	5	12	81	L1	6.1	7.07	0.1	70	6.8	0.108	0.037	0.010	0.235	0.76
31	5	28	81	L1	0.3	18.05	9.0	89	6.9	0.017	0.003	0.013	0.010	0.34
32	5	28	81	L1	1.2	18.07	9.2	88	6.9	0.014	0.003	0.008	0.007	0.28
33	5	28	81	L1	2.4	15.95	8.8	84	7.0	0.017	0.003	0.008	0.004	0.31
34	5	28	81	L1	3.7	12.19	2.6	75	6.9	0.018	0.003	0.008	0.007	0.25
35	5	28	81	L1	4.9	9.25	0.6	71	6.8	0.036	.	0.008	0.014	0.48
36	5	28	81	L1	6.1	7.87	0.2	73	6.6	0.088	.	0.008	0.250	0.88
37	6	10	81	L1	0.3	16.93	8.6	85	6.7	0.022	0.003	0.008	0.013	0.45
38	6	10	81	L1	1.2	16.97	8.9	84	6.8	0.023	0.006	0.013	0.008	0.56
39	6	10	81	L1	2.4	16.78	7.0	84	6.7	0.037	0.007	0.030	0.016	0.39
40	6	10	81	L1	3.7	13.67	1.3	78	6.5	0.036	0.007	0.012	0.013	0.45
41	6	10	81	L1	4.9	10.20	0.4	75	6.4	0.043	0.003	0.008	0.008	0.39
42	6	10	81	L1	6.1	7.87	0.4	71	6.5	0.080	0.025	0.008	0.200	0.64
43	6	25	81	L1	0.3	20.10	8.6	221	7.1	0.013	0.003	0.008	0.009	0.48
44	6	25	81	L1	1.2	20.00	8.9	213	7.0	0.010	0.003	0.018	0.008	0.53
45	6	25	81	L1	2.4	19.11	9.2	202	7.0	0.011	0.003	0.008	0.006	0.45
46	6	25	81	L1	3.7	15.07	1.0	184	6.6	0.046	0.003	0.012	0.007	0.39
47	6	25	81	L1	4.9	11.30	0.3	170	6.4	0.046	0.003	0.036	0.005	0.56
48	6	25	81	L1	6.1	9.40	0.1	169	6.5	0.126	0.061	0.018	0.270	0.84
49	7	9	81	L1	0.3	20.38	8.6	95	7.1	0.003	0.003	0.017	0.014	0.53
50	7	9	81	L1	1.2	20.38	8.5	95	7.1	0.003	0.003	0.008	0.005	0.36
51	7	9	81	L1	2.4	19.94	7.7	94	7.1	0.003	0.003	0.024	0.010	0.42
52	7	9	81	L1	3.7	14.61	0.5	85	6.9	0.019	0.006	0.028	0.011	0.56

WATER COLUMN DATA

VALUES ANALYZED AT DISCRETE DEPTHS OR FROM DISCRETE SAMPLES
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
CONDUCTIVITY AS UMOHS/CM2, PH AS UNITS

OBS	MN	DAY	YR	STATION	DEPTH_M	W_TEMP_C	D_O	COND	PH	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N
53	7	9	81	L1	4.9	10.33	0.7	84	6.5	0.025	0.003	0.008	0.018	0.59
54	7	9	81	L1	6.1	8.33	0.9	84	6.3	0.023	0.006	0.032	0.013	0.48
55	7	23	81	L1	0.3	20.58	8.7	92	7.0	0.009	0.003	0.008	0.003	0.42
56	7	23	81	L1	1.2	20.59	8.6	92	7.0	0.022	0.003	0.008	0.003	0.45
57	7	23	81	L1	2.4	20.64	8.4	92	7.0	0.015	0.003	0.008	0.003	0.48
58	7	23	81	L1	3.7	15.43	1.0	84	6.8	0.041	0.003	0.016	0.006	0.50
59	7	23	81	L1	4.9	10.61	0.3	77	6.5	0.033	0.003	0.008	0.005	0.64
60	7	23	81	L1	6.1	8.29	0.0	81	6.3	0.095	0.066	0.024	0.038	0.50
61	8	11	81	L1	0.3	25.57	8.0	106	6.9	0.022	0.003	0.071	0.009	0.22
62	8	11	81	L1	1.2	25.57	8.1	105	7.3	0.036	0.003	0.014	0.008	0.34
63	8	11	81	L1	2.4	23.49	8.1	102	7.2	0.027	0.003	0.010	0.010	0.28
64	8	11	81	L1	3.7	16.88	6.7	87	6.9	0.107	0.003	0.008	0.011	0.73
65	8	11	81	L1	4.9	10.80	1.0	78	6.5	0.067	0.003	0.008	0.008	0.62
66	8	11	81	L1	6.1	8.12	0.0	82	6.4	0.131	0.048	0.058	0.018	0.53
67	8	27	81	L1	0.3	21.39	8.6	.	7.0	0.019	0.003	0.008	0.005	0.50
68	8	27	81	L1	1.2	21.41	7.9	.	7.1	0.025	0.009	0.008	0.003	0.50
69	8	27	81	L1	2.4	21.42	7.6	.	7.1	0.022	0.003	0.010	0.003	0.56
70	8	27	81	L1	3.7	18.06	0.9	.	6.8	0.037	0.003	0.008	0.012	0.62
71	8	27	81	L1	4.9	11.39	0.4	.	6.5	0.067	0.003	0.008	0.007	0.70
72	8	27	81	L1	6.1	9.02	0.0	.	6.2	0.137	0.070	0.008	0.020	0.73
73	10	2	81	L1	0.3	15.53	7.5	85	6.9	0.015	0.011	0.008	0.014	0.42
74	10	2	81	L1	1.2	15.59	7.5	84	7.1	0.015	0.003	0.008	0.006	0.34
75	10	2	81	L1	2.4	15.61	7.4	83	6.9	0.017	0.006	0.011	0.010	0.42
76	10	2	81	L1	3.7	15.66	7.4	84	6.9	0.014	0.003	0.014	0.006	0.45
77	10	2	81	L1	4.9	14.52	4.3	83	6.8	0.039	0.003	0.008	0.011	0.48
78	10	2	81	L1	6.1	10.01	0.0	97	6.4	0.047	0.009	0.008	0.011	0.70
79	11	4	81	L1	0.3	10.94	5.7	66	7.5	0.028	0.003	0.030	0.031	0.53
80	11	4	81	L1	1.2	10.94	5.5	67	7.3	0.035	0.003	0.041	0.028	0.50
81	11	4	81	L1	2.4	10.99	5.5	64	7.1	0.095	0.003	0.025	0.019	0.73
82	11	4	81	L1	3.7	10.99	5.4	64	7.0	0.028	0.003	0.023	0.034	0.95
83	11	4	81	L1	4.9	10.91	5.0	63	7.3	0.084	0.003	0.025	0.020	0.53
84	11	4	81	L1	6.1	10.59	1.3	70	7.5	0.058	0.006	0.008	0.132	0.59

EUPHOTIC ZONE INFORMATION AND COMPOSITE DATA

VALUES ANALYZED FROM EUPHOTIC ZONE COMPOSITE SAMPLES
ALL DEPTHS EXPRESSED AS METERS
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
ALKALINITY AND HARDNESS AS MG/L CALCIUM CARBONATE

OBS	MN	DAY	YR	STATION	E_Z_D	COMP_D	SECCHI_D	TSS	CHL_A	TTL_HRDN	CA_HRDN	PPTH_ALK	MO_ALK
1	1	14	81	L1	3.0	3.0	2.4	1	1.79	34	20	0	30
2	2	23	81	L1	2.5	2.4	1.5	4	5.95	32	20	0	25
3	3	27	81	L1	3.6	3.7	2.7	4	30.40	38	20	0	25
4	4	28	81	L1	3.8	3.7	2.5	1	25.10	32	24	0	35
5	5	12	81	L1	2.8	2.4	1.5	2	7.68	34	30	0	35
6	5	28	81	L1	3.8	3.7	3.0	1	3.17	38	28	0	30
7	6	10	81	L1	4.0	3.7	3.1	2	9.71	44	26	0	35
8	6	25	81	L1	3.2	3.2	2.5	3	6.08	38	24	0	30
9	7	9	81	L1	3.0	3.0	2.5	2	7.73	46	16	0	45
10	7	23	81	L1	3.9	3.7	2.7	2	13.80	36	24	0	45
11	8	11	81	L1	3.0	2.4	2.7	3	4.08	40	24	0	25
12	8	27	81	L1	4.3	3.7	3.4	1	16.70	34	18	0	65
13	10	2	81	L1	2.5	2.4	2.1	4	17.80	38	30	0	55
14	11	4	81	L1	4.0	3.7	2.9	2	10.90	38	24	0	45

LAKE FENWICK HYDROLOGIC INFORMATION

LAKE AND POND LEVELS EXPRESSED AS FEET ABOVE ARBITRARY DATUM
INSTANTANEOUS FLOWS EXPRESSED AS CUBIC FEET PER SECOND

OBS	MN	DAY	YR	LAKE_LVL	POND_LVL	I_INST_Q	O_INST_Q
1	1	14	81	4.22	5.38	0.096	0.56
2	2	23	81	4.52	5.48	0.268	0.56
3	3	27	81	4.42	5.62	0.680	0.30
4	4	28	81	4.30	5.56	0.475	0.00
5	5	12	81	4.24	5.40	0.121	0.00
6	5	28	81	4.14	5.40	0.121	0.00
7	6	10	81	4.82	5.50	0.314	0.78
8	6	25	81	4.22	5.44	0.186	0.00
9	7	9	81	3.72	5.30	0.000	0.00
10	7	23	81	3.62	5.20	0.000	0.00
11	8	11	81	3.08	4.62	0.000	0.00
12	8	28	81	2.90	4.14	0.000	0.00
13	10	2	81	3.82	5.60	0.604	0.00
14	11	4	81	3.72	5.32	0.038	0.00

NW INLET NORMAL FLOW MONITORING DATA - LAKE FENWICK

VALUES ANALYZED FROM DISCRETE SAMPLES AT STATION IL
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
ALKALINITY AND HARDNESS AS MG/L CALCIUM CARBONATE

OBS	MN	DAY	YR	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N	TSS	TTL_HRDN	CA_HRDN	PPTH_ALK	MO_ALK
1	1	14	81	0.029	0.008	0.910	0.152	0.67	2	74	53	0	50
2	2	23	81	0.089	0.009	1.250	0.065	0.67	3	42	34	0	40
3	3	27	81	0.085	0.003	0.380	0.026	0.78	8	48	30	0	40
4	4	28	81	0.086	0.006	0.360	0.044	1.18	5	60	50	0	50
5	5	12	81	0.079	0.003	0.204	0.025	0.81	12	60	38	0	50
6	5	28	81	0.060	0.005	0.341	0.064	0.81	4	66	66	0	65
7	6	10	81	0.146	0.016	0.374	0.125	0.81	21	40	20	0	25
8	6	25	81	0.094	0.003	0.161	0.051	1.06	9	56	42	0	40
9	10	2	81	0.080	0.035	0.478	0.059	1.06	4	32	24	0	55
10	11	4	81	0.073	0.006	0.108	0.092	0.77	4	78	34	0	80

STATISTICS FOR INLET NORMAL FLOW MONITORING DATA

VALUES ANALYZED FROM DISCRETE SAMPLES AT STATION IL
CHEMICAL VALUES EXPRESSED AS MILLIGRAMS PER LITER
ALKALINITY AND HARDNESS AS MG/L CALCIUM CARBONATE

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TP_P	10	0.082	0.029	0.029	0.146
OP_P	10	0.009	0.010	0.003	0.035
NO3NO2_N	10	0.457	0.356	0.108	1.250
NH3_N	10	0.070	0.041	0.025	0.152
TKN_N	10	0.862	0.175	0.670	1.180
TSS	10	7.200	5.750	2.000	21.000
TTL_HRDN	10	55.600	15.020	32.000	78.000
CA_HRDN	10	39.100	14.035	20.000	66.000
PPTH_ALK	10	0.000	0.000	0.000	0.000
MO_ALK	10	49.500	15.175	25.000	80.000

APPENDIX B

BIOLOGICAL DATA

LAKE FENWICK PHYTOPLANKTON SUMMARY BY SPECIES

OBS	SPEC_NO	COUNT	CELL_VOL	MN	DAY	YR
1	MICROPLANKTON NO 2	0.043	0.001	1	14	81
2	RHODOMONAS SP	0.026	0.002	1	14	81
3	OSCILLATORIA SUBBREVIS	0.013	0.006	1	14	81
4	MICROPLANKTON NO 3	0.086	0.008	1	14	81
5	MALLOMONAS SP	0.013	0.012	1	14	81
6	MICROPLANKTON NO 1	0.043	0.017	1	14	81
7	MALLOMONAS ACAROIDES	0.043	0.061	1	14	81
8	CRYPTOMONAS SP	0.052	0.102	1	14	81
9	CRYPTOMONAS OVATA	0.039	0.228	1	14	81
10	MICROPLANKTON NO 1	0.087	0.003	2	23	81
11	MICROPLANKTON NO 2	0.433	0.010	2	23	81
12	RHODOMONAS SP	0.221	0.048	2	23	81
13	OSCILLATORIA SUBBREVIS	0.052	0.121	2	23	81
14	CRYPTOMONAS SP	0.078	0.175	2	23	81
15	CRYPTOMONAS SP	0.039	0.289	2	23	81
16	CRYPTOMONAS OVATA	0.182	0.658	2	23	81
17	DINOBRYON BAVARICUM	0.052	0.011	3	27	81
18	MICROPLANKTON NO 1	0.520	0.022	3	27	81
19	OSCILLATORIA SUBBREVIS	0.026	0.027	3	27	81
20	MICROPLANKTON NO 2	0.260	0.029	3	27	81
21	PHACUS SP	0.156	0.088	3	27	81
22	RHODOMONAS SP	0.987	0.133	3	27	81
23	CRYPTOMONAS SP	0.078	0.157	3	27	81
24	ASTERIONELLA FORMOSA	0.831	0.297	3	27	81
25	DINOBRYON SERTULARIA	1.896	0.692	3	27	81
26	CRYPTOMONAS OVATA	0.597	1.892	3	27	81
27	DINOBRYON SERTULARIA	0.026	0.005	4	28	81
28	MICROPLANKTON NO 1	0.953	0.054	4	28	81
29	CRYPTOMONAS SP	0.078	0.163	4	28	81
30	ASTERIONELLA FORMOSA	0.597	0.214	4	28	81
31	CHARACIUM SP	0.052	0.352	4	28	81
32	CHROMULINA SP	1.922	1.019	4	28	81
33	MICROPLANKTON NO 2	0.087	0.010	5	12	81
34	SYNEDRA SP	0.052	0.012	5	12	81
35	RHODOMONAS SP	0.208	0.022	5	12	81
36	MICROPLANKTON NO 1	0.087	0.032	5	12	81
37	APHANIZOMENON FLOS-AQUAE	0.026	0.085	5	12	81
38	CHROMULINA SP	0.087	0.107	5	12	81
39	DINOBRYON SERTULARIA	2.831	0.436	5	12	81
40	ASTERIONELLA FORMOSA	4.544	1.659	5	12	81
41	SYNEDRA SP	0.026	0.007	5	28	81
42	RHODOMONAS SP	0.130	0.010	5	28	81
43	MICROPLANKTON NO 2	0.260	0.014	5	28	81
44	MICROPLANKTON NO 1	0.867	0.036	5	28	81
45	DINOBRYON SERTULARIA	0.909	0.151	5	28	81
46	CRYPTOMONAS SP	0.087	0.171	5	28	81
47	ASTERIONELLA FORMOSA	0.597	0.237	5	28	81
48	SCHROEDERIA JUDAYI	0.078	0.001	6	9	81
49	KEPHYRION SPIRALE	0.087	0.004	6	9	81
50	MICROPLANKTON NO 2	0.607	0.026	6	9	81
51	RHODOMONAS SP	0.182	0.027	6	9	81
52	ANABAENA SP	0.026	0.033	6	9	81
53	MICROPLANKTON NO 1	5.893	0.047	6	9	81
54	SPHAEROCYSTIS SCHROETERI	0.156	0.049	6	9	81
55	OOCYSTIS SP	0.208	0.101	6	9	81
56	CHARACIUM SP	0.026	0.111	6	9	81
57	MALLOMONAS CAUDATA	0.087	0.165	6	9	81
58	APHANIZOMENON FLOS-AQUAE	0.104	0.214	6	9	81
59	ANABAENA SP	0.052	0.827	6	9	81
60	SCHROEDERIA JUDAYI	0.026	0.000	6	25	81
61	CRYPTOMONAS SP	0.026	0.021	6	25	81
62	MICROPLANKTON NO 1	0.607	0.031	6	25	81
63	MICROPLANKTON NO 2	0.867	0.055	6	25	81
64	RHODOMONAS SP	0.649	0.060	6	25	81
65	ANABAENA SP	0.087	0.114	6	25	81
66	CHLORELLA SP	0.780	0.129	6	25	81
67	ANABAENA PLANCTONICA	0.260	0.147	6	25	81
68	CHARACIUM SP	0.026	0.201	6	25	81
69	OOCYSTIS SP	0.649	0.246	6	25	81
70	APHANIZOMENON FLOS-AQUAE	0.390	0.464	6	25	81
71	ANABAENA SP	0.130	1.299	6	25	81
72	MICROPLANKTON NO 1	0.260	0.014	7	9	81
73	RHODOMONAS SP	0.208	0.025	7	9	81

LAKE FENWICK PHYTOPLANKTON SUMMARY BY SPECIES

OBS	SPEC_NO	COUNT	CELL_VOL	MN	DAY	YR
74	CRYPTOMONAS OVATA	0.104	0.059	7	9	81
75	DINOBRYON SP	0.286	0.063	7	9	81
76	CHARACIUM SP	0.026	0.138	7	9	81
77	APHANIZOMENON FLOS-AQUAE	0.182	0.198	7	9	81
78	MICROPLANKTON NO 2	1.993	0.201	7	9	81
79	ANABAENA SP	0.026	0.257	7	9	81
80	SPHAEROCYSTIS SCHROETERI	0.234	0.308	7	9	81
81	SCENDESMUS BIJUGA	0.104	0.002	7	23	81
82	DINOBRYON SP	0.026	0.003	7	23	81
83	RHODOMONAS SP	0.078	0.008	7	23	81
84	SPHAEROCYSTIS SCHROETERI	0.312	0.018	7	23	81
85	MICROPLANKTON NO 2	0.693	0.021	7	23	81
86	TETRADESMUS SMITHII	0.208	0.023	7	23	81
87	QUADRIGULA SP	0.173	0.026	7	23	81
88	OSCILLATORIA SUBBREVIS	0.026	0.068	7	23	81
89	MICROPLANKTON NO 1	5.286	0.090	7	23	81
90	APHANIZOMENON FLOS-AQUAE	0.156	0.189	7	23	81
91	CRYPTOMONAS SP	0.052	0.210	7	23	81
92	ANABAENA SP	0.026	0.318	7	23	81
93	MELOSIRA GRANULATA	0.347	0.318	7	23	81
94	ANKISTRODESMUS FALCATUS	0.026	0.003	8	11	81
95	CRUCIGENIA TETRAPEDIA	0.347	0.003	8	11	81
96	DINOBRYON SP	0.026	0.006	8	11	81
97	ASTERIONELLA FORMOSA	0.078	0.025	8	11	81
98	CHROMULINA SP	0.087	0.025	8	11	81
99	MICROPLANKTON NO 1	0.780	0.042	8	11	81
100	PROTOCOCCUS SP	0.831	0.048	8	11	81
101	RHODOMONAS SP	0.623	0.064	8	11	81
102	MICROPLANKTON NO 2	1.993	0.096	8	11	81
103	CRYPTOMONAS SP	0.104	0.222	8	11	81
104	ANKISTRODESMUS FALCATUS	0.013	0.000	8	27	81
105	CRUCIGENIA TETRAPEDIA	0.052	0.001	8	27	81
106	SCENDESMUS BIJUGA	0.173	0.005	8	27	81
107	CRYPTOMONAS SP	0.039	0.016	8	27	81
108	MELOSIRA GRANULATA	0.026	0.017	8	27	81
109	RHODOMONAS SP	0.221	0.020	8	27	81
110	MICROPLANKTON NO 1	0.737	0.021	8	27	81
111	MICROPLANKTON NO 2	0.520	0.025	8	27	81
112	SPHAEROCYSTIS SCHROETERI	2.036	0.043	8	27	81
113	MELOSIRA SP	0.130	0.073	8	27	81
114	ASTERIONELLA FORMOSA	0.195	0.103	8	27	81
115	CERATIUM HIUNDINELLA	0.039	0.105	8	27	81
116	DINOBRYON SERTULARIA	0.351	0.114	8	27	81
117	MICROCYSTIS AERUGINOSA	5.329	0.117	8	27	81
118	FRAGILARIA CROTONENSIS	0.441	0.220	8	27	81
119	ANABAENA PLANCTONICA	0.039	0.362	8	27	81
120	CRYPTOMONAS SP	0.013	0.004	10	2	81
121	RHODOMONAS SP	0.043	0.004	10	2	81
122	SCENDESMUS BIJUGA	0.182	0.008	10	2	81
123	MICROPLANKTON NO 1	0.910	0.015	10	2	81
124	MICROPLANKTON NO 2	0.693	0.030	10	2	81
125	RHODOMONAS SP	0.441	0.048	10	2	81
126	SYNEDRA SP	0.043	0.050	10	2	81
127	APHANIZOMENON FLOS-AQUAE	0.065	0.071	10	2	81
128	MELOSIRA GRANULATA	0.636	0.207	10	2	81
129	TABELLARIA FENESTRATA	0.104	0.323	10	2	81
130	MICROCYSTIS AERUGINOSA	17.461	0.419	10	2	81
131	ANABAENA PLANCTONICA	0.052	0.449	10	2	81
132	ASTERIONELLA FORMOSA	1.740	0.670	10	2	81
133	ANKISTRODESMUS FALCATUS	0.026	0.005	11	4	81
134	DINOBRYON SP	0.087	0.008	11	4	81
135	RHODOMONAS SP	0.260	0.010	11	4	81
136	MICROPLANKTON NO 2	1.820	0.024	11	4	81
137	RHODOMONAS SP	0.156	0.028	11	4	81
138	MICROPLANKTON NO 1	2.773	0.047	11	4	81
139	CRYPTOMONAS SP	0.052	0.051	11	4	81
140	APHANIZOMENON SP	0.078	0.111	11	4	81
141	CRYPTOMONAS SP	0.026	0.289	11	4	81
142	MELOSIRA GRANULATA	2.337	0.881	11	4	81

LAKE FENWICK ZOOPLANKTON SUMMARY BY SPECIES

OBS	TAXA_NO	ABUN	MN	DAY	YR
1	BOSMINA LONGIROSTRIS	0.310	1	14	81
2	CERIODAPHNIA LACUSTRIS	1.100	1	14	81
3	ASPLANCHNA PRIODONTA	1.410	1	14	81
4	POMPHOLYX SULCATA	1.720	1	14	81
5	ASCOMORPHA SP	1.880	1	14	81
6	KELLICOTTIA LONGISPINA	2.510	1	14	81
7	ANUREOPSIS FISSA	2.980	1	14	81
8	CYCLOPOID COPEPODID	3.130	1	14	81
9	NAUPLII	3.130	1	14	81
10	POLYARTHRA VULGARIS	5.010	1	14	81
11	KERATELLA QUADRATA	5.800	1	14	81
12	DAPHNIA ROSEA	7.840	1	14	81
13	SYNCHAETA PECTINATA	10.970	1	14	81
14	KERATELLA COCHLEARIS	20.840	1	14	81
15	BOSMINA LONGIROSTRIS	0.160	2	23	81
16	DAPHNIA ROSEA	0.160	2	23	81
17	CALANOID COPEPODID	0.160	2	23	81
18	CERIODAPHNIA LACUSTRIS	0.310	2	23	81
19	KERATELLA SERRULATA	0.310	2	23	81
20	ASPLANCHNA PRIODONTA	0.470	2	23	81
21	FILINIA LONGISETA	0.470	2	23	81
22	CYCLOPOID COPEPODID	1.250	2	23	81
23	POMPHOLYX SULCATA	1.250	2	23	81
24	NAUPLII	2.350	2	23	81
25	ASCOMORPHA SP	2.820	2	23	81
26	ANUREOPSIS FISSA	3.130	2	23	81
27	KELLICOTTIA LONGISPINA	3.290	2	23	81
28	EPIPHANES SENTA	3.760	2	23	81
29	POLYARTHRA VULGARIS	12.540	2	23	81
30	SYNCHAETA PECTINATA	13.480	2	23	81
31	KERATELLA QUADRATA	15.510	2	23	81
32	KERATELLA COCHLEARIS	17.240	2	23	81
33	CALANOID COPEPODID	0.420	3	27	81
34	ANUREOPSIS FISSA	0.420	3	27	81
35	COLLOTHECA BALATONICA	0.420	3	27	81
36	CONOCHILUS SP	0.420	3	27	81
37	FILINIA LONGISETA	0.420	3	27	81
38	DAPHNIA ROSEA	0.630	3	27	81
39	CYCLOPOID COPEPODID	1.040	3	27	81
40	POMPHOLYX SULCATA	2.090	3	27	81
41	EPIPHANES SENTA	2.720	3	27	81
42	NAUPLII	7.310	3	27	81
43	KERATELLA QUADRATA	7.940	3	27	81
44	KELLICOTTIA LONGISPINA	10.030	3	27	81
45	ASCOMORPHA SP	14.210	3	27	81
46	SYNCHAETA PECTINATA	23.810	3	27	81
47	KERATELLA COCHLEARIS	41.150	3	27	81
48	POLYARTHRA VULGARIS	80.220	3	27	81
49	CERIODAPHNIA LACUSTRIS	0.026	4	28	81
50	DIAPTOMUS FRANCISCANUS	0.260	4	28	81
51	ASPLANCHNA PRIODONTA	0.260	4	28	81
52	COLLOTHECA BALATONICA	0.260	4	28	81
53	GASTROPUS HYPTOPUS	0.260	4	28	81
54	CALANOID COPEPODID	0.780	4	28	81
55	ASCOMORPHA SP	3.400	4	28	81
56	CYCLOPOID COPEPODID	3.920	4	28	81
57	POMPHOLYX SULCATA	4.18	4	28	81
58	DAPHNIA ROSEA	6.79	4	28	81
59	KELLICOTTIA LONGISPINA	7.31	4	28	81
60	KERATELLA QUADRATA	8.36	4	28	81
61	POLYARTHRA VULGARIS	11.23	4	28	81
62	SYNCHAETA PECTINATA	12.02	4	28	81
63	FILINIA LONGISETA	14.37	4	28	81
64	NAUPLII	34.22	4	28	81
65	KERATELLA COCHLEARIS	53.82	4	28	81
66	TRICHOCERA CAPUCINA	0.24	5	12	81
67	UNKNOWN ROTIFER	0.24	5	12	81
68	CALANOID COPEPODID	1.88	5	12	81
69	CYCLOPOID COPEPODID	2.35	5	12	81
70	SYNCHAETA PECTINATA	2.59	5	12	81
71	TRICHOCERA SP	2.82	5	12	81
72	GASTROPUS SP	3.06	5	12	81
73	DAPHNIA ROSEA	3.29	5	12	81
74	POMPHOLYX SULCATA	3.53	5	12	81
75	FILINIA LONGISETA	5.17	5	12	81
76	ASCOMORPHA SP	5.64	5	12	81
77	KELLICOTTIA LONGISPINA	6.11	5	12	81
78	KERATELLA QUADRATA	6.11	5	12	81
79	POLYARTHRA VULGARIS	7.29	5	12	81
80	NAUPLII	13.64	5	12	81
81	KERATELLA COCHLEARIS	15.28	5	12	81
82	ASPLANCHNA PRIODONTA	24.69	5	12	81
83	DIAPTOMUS FRANCISCANUS	0.21	5	28	81
84	DIAPTOMUS REIGHARDI	0.21	5	28	81
85	FILINIA LONGISETA	0.21	5	28	81
86	TRICHOCERA CAPUCINA	0.21	5	28	81
87	ANUREOPSIS FISSA	0.63	5	28	81
88	GASTROPUS SP	0.63	5	28	81
89	SYNCHAETA PECTINATA	0.63	5	28	81
90	CALANOID COPEPODID	0.84	5	28	81
91	DAPHNIA ROSEA	1.04	5	28	81
92	TESTUDINELLA PATINA	1.04	5	28	81
93	TRICHOCERA SP	1.67	5	28	81
94	CYCLOPOID COPEPODID	2.30	5	28	81
95	KERATELLA QUADRATA	2.30	5	28	81
96	POMPHOLYX SULCATA	5.01	5	28	81
97	ASPLANCHNA PRIODONTA	5.22	5	28	81
98	KERATELLA COCHLEARIS	7.52	5	28	81

LAKE FENWICK ZOOPLANKTON SUMMARY BY SPECIES

OBS	TAXA_NO	ABUN	MN	DAY	YR
99	KELLICOTTIA LONGISPINA	8.56	5	28	81
100	NAUPLII	9.40	5	28	81
101	POLYARTHRA VULGARIS	11.28	5	28	81
102	CERIODAPHNIA LACUSTRIS	0.16	6	9	81
103	GASTROPUS HYPTOPUS	0.16	6	9	81
104	TRICHOCERA SP	0.16	6	9	81
105	CHAOBORUS SP	0.16	6	9	81
106	DIAPTOMUS REIGHARDI	0.31	6	9	81
107	DIAPTOMUS FRANCISCANUS	0.47	6	9	81
108	CYCLOPOID COPEPODID	0.78	6	9	81
109	KERATELLA QUADRATA	0.78	6	9	81
110	CALANOID COPEPODID	1.10	6	9	81
111	POMPHOLYX SULCATA	1.25	6	9	81
112	CONOCHILUS SP	1.41	6	9	81
113	ASCOMORPHA SP	2.04	6	9	81
114	DAPHNIA ROSEA	2.82	6	9	81
115	NAUPLII	2.98	6	9	81
116	TESTUDINELLA PATINA	3.45	6	9	81
117	POLYARTHRA VULGARIS	5.48	6	9	81
118	KERATELLA COCHLEARIS	6.11	6	9	81
119	KELLICOTTIA LONGISPINA	11.44	6	9	81
120	FILINIA LONGISETA	22.09	6	9	81
121	DIAPTOMUS REIGHARDI	0.18	6	25	81
122	SYNCHAETA PECTINATA	0.18	6	25	81
123	TRICHOCERCA CYLINDRICA	0.18	6	25	81
124	DIAPTOMUS FRANCISCANUS	0.37	6	25	81
125	TRICHOCERA SP	0.37	6	25	81
126	CHAOBORUS SP	0.55	6	25	81
127	GASTROPUS HYPTOPUS	0.73	6	25	81
128	TESTUDINELLA PATINA	1.46	6	25	81
129	ASCOMORPHA SP	2.01	6	25	81
130	KERATELLA COCHLEARIS	2.01	6	25	81
131	NAUPLII	6.95	6	25	81
132	POLYARTHRA VULGARIS	10.97	6	25	81
133	KELLICOTTIA LONGISPINA	14.62	6	25	81
134	CONOCHILUS SP	14.81	6	25	81
135	POMPHOLYX SULCATA	24.13	6	25	81
136	FILINIA LONGISETA	40.95	6	25	81
137	CALANOID COPEPODID	0.26	7	9	81
138	DIAPTOMUS REIGHARDI	0.26	7	9	81
139	TRICHOCERA CAPUCINA	0.26	7	9	81
140	CHAOBORUS SP	0.26	7	9	81
141	CERIODAPHNIA LACUSTRIS	0.52	7	9	81
142	DIAPTOMUS FRANCISCANUS	0.52	7	9	81
143	TESTUDINELLA PATINA	0.52	7	9	81
144	ANUREOPSIS FISSA	1.04	7	9	81
145	GASTROPUS HYPTOPUS	1.31	7	9	81
146	ASCOMORPHA SP	2.35	7	9	81
147	POLYARTHRA VULGARIS	3.66	7	9	81
148	KERATELLA COCHLEARIS	3.92	7	9	81
149	TRICHOCERCA CYLINDRICA	4.70	7	9	81
150	NAUPLII	4.96	7	9	81
151	FILINIA LONGISETA	6.01	7	9	81
152	CONOCHILUS SP	6.79	7	9	81
153	KELLICOTTIA LONGISPINA	13.32	7	9	81
154	POMPHOLYX SULCATA	15.67	7	9	81
155	TESTUDINELLA PATINA	0.26	7	23	81
156	CERIODAPHNIA LACUSTRIS	0.52	7	23	81
157	CYCLOPOID COPEPODID	0.52	7	23	81
158	CHAOBORUS SP	0.52	7	23	81
159	SYNCHAETA PECTINATA	0.78	7	23	81
160	DIAPTOMUS FRANCISCANUS	1.04	7	23	81
161	NAUPLII	1.04	7	23	81
162	CONOCHILUS SP	1.04	7	23	81
163	TRICHOCERCA CYLINDRICA	1.04	7	23	81
164	ASCOMORPHA SP	1.83	7	23	81
165	FILINIA LONGISETA	2.61	7	23	81
166	GASTROPUS HYPTOPUS	2.87	7	23	81
167	KERATELLA COCHLEARIS	3.92	7	23	81
168	KELLICOTTIA LONGISPINA	4.18	7	23	81

LAKE FENWICK ZOOPLANKTON SUMMARY BY SPECIES

OBS	TAXA_NO	ABUN	MN	DAY	YR
169	COLLOTHECA BALATONICA	4.70	7	23	81
170	POLYARTHRA VULGARIS	6.79	7	23	81
171	POMPHOLYX SULCATA	10.97	7	23	81
172	TESTUDINELLA PATINA	0.24	8	11	81
173	TRICHOCERA CAPUCINA	0.24	8	11	81
174	CERIODAPHNIA LACUSTRIS	0.47	8	11	81
175	GASTROPUS HYPTOPUS	0.47	8	11	81
176	SYNCHAETA PECTINATA	0.47	8	11	81
177	DIAPHANOSOMA LEUCHTENBERGIANUM	0.71	8	11	81
178	ANUREOPSIS FISSA	0.94	8	11	81
179	CHAOBORUS SP	0.94	8	11	81
180	NAUPLII	1.41	8	11	81
181	KELLICOTTIA LONGISPINA	1.41	8	11	81
182	TRICHOCERCA CYLINDRICA	1.41	8	11	81
183	ASCOMORPHA OVALIS	2.59	8	11	81
184	KERATELLA COCHLEARIS	3.06	8	11	81
185	ASCOMORPHA SP	4.70	8	11	81
186	CONOCHILUS SP	6.58	8	11	81
187	POLYARTHRA VULGARIS	15.75	8	11	81
188	POMPHOLYX SULCATA	25.63	8	11	81
189	CERIODAPHNIA LACUSTRIS	0.24	8	27	81
190	CONOCHILUS SP	0.24	8	27	81
191	DIAPHANOSOMA LEUCHTENBERGIANUM	0.47	8	27	81
192	KELLICOTTIA LONGISPINA	0.47	8	27	81
193	TRICHOCERA CAPUCINA	0.47	8	27	81
194	TESTUDINELLA PATINA	0.71	8	27	81
195	CHAOBORUS SP	0.94	8	27	81
196	NAUPLII	1.18	8	27	81
197	TRICHOCERCA CYLINDRICA	1.41	8	27	81
198	POMPHOLYX SULCATA	1.47	8	27	81
199	KERATELLA COCHLEARIS	3.29	8	27	81
200	POLYARTHRA VULGARIS	7.52	8	27	81
201	ASCOMORPHA OVALIS	7.99	8	27	81
202	POMPHOLYX SULCATA	10.81	8	27	81
203	ASCOMORPHA SP	20.92	8	27	81
204	CALANOID COPEPODID	0.37	10	2	81
205	DIAPTOMUS FRANCISCANUS	0.37	10	2	81
206	COLLOTHECA BALATONICA	0.37	10	2	81
207	HEXARTHRA MIRA	0.37	10	2	81
208	SYNCHAETA PECTINATA	0.37	10	2	81
209	TRICHOCERCA CYLINDRICA	0.37	10	2	81
210	KERATELLA QUADRATA	1.11	10	2	81
211	KELLICOTTIA LONGISPINA	1.48	10	2	81
212	CONOCHILUS SP	1.85	10	2	81
213	TRICHOCERA CAPUCINA	1.85	10	2	81
214	ASCOMORPHA OVALIS	2.22	10	2	81
215	CERIODAPHNIA LACUSTRIS	2.96	10	2	81
216	NAUPLII	3.33	10	2	81
217	TESTUDINELLA PATINA	3.70	10	2	81
218	POMPHOLYX SULCATA	4.07	10	2	81
219	POLYARTHRA VULGARIS	6.29	10	2	81
220	KERATELLA COCHLEARIS	6.66	10	2	81
221	ASCOMORPHA SP	64.75	10	2	81
222	CERIODAPHNIA LACUSTRIS	0.44	11	14	81
223	TESTUDINELLA PATINA	0.44	11	14	81
224	FILINIA LONGISETA	0.87	11	14	81
225	GASTROPUS HYPTOPUS	1.74	11	14	81
226	TRICHOCERA CAPUCINA	2.61	11	14	81
227	SYNCHAETA PECTINATA	3.05	11	14	81
228	ANUREOPSIS FISSA	6.09	11	14	81
229	NAUPLII	15.24	11	14	81
230	KELLICOTTIA LONGISPINA	28.73	11	14	81
231	KERATELLA QUADRATA	47.01	11	14	81
232	KERATELLA COCHLEARIS	48.75	11	14	81
233	POLYARTHRA VULGARIS	53.11	11	14	81
234	POMPHOLYX SULCATA	215.47	11	14	81

APPENDIX C

STORMWATER DATA

LAKE FENWICK STORM DATA

NUTRIENTS AND SUSPENDED SOLIDS MEASURED IN THE LAKE AFTER EACH STORM

VALUES ESPRESSED AS MG/L

OBS	MM	DAY	YR	STATION	DEPTH_M	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N	TSS
1	7	14	81	L1	0.30	0.014	0.003	0.008	0.016	0.42	1
2	7	14	81	L1	2.40	0.018	0.003	0.087	0.062	0.73	2
3	7	14	81	L2	0.30	0.014	0.003	0.008	0.013	0.34	1
4	7	14	81	L2	2.40	0.003	0.003	0.008	0.021	0.56	2
5	7	14	81	L3	0.30	0.007	0.003	0.008	0.018	0.78	2
6	7	14	81	L3	1.00	0.003	0.003	0.008	0.035	0.56	2
7	7	14	81	L4	0.30	0.003	0.003	0.008	0.003	0.53	1
8	7	14	81	L4	1.00	0.044	0.003	0.047	0.039	0.64	10
9	7	14	81	L5	0.30	0.003	0.005	0.008	0.015	1.00	1
10	7	14	81	L5	1.00	0.051	0.003	0.025	0.030	0.75	9
11	11	13	81	L1	0.30	0.028	0.006	0.013	0.013	0.31	3
12	11	13	81	L1	1.00	0.023	0.008	0.015	0.019	0.31	3
13	11	13	81	L2	0.30	0.031	0.003	0.022	0.014	0.31	5
14	11	13	81	L2	2.40	0.030	0.003	0.043	0.015	0.36	4
15	11	13	81	L3	0.30	0.036	0.012	0.051	0.015	0.22	6
16	11	13	81	L3	2.40	0.068	0.005	0.123	0.047	0.50	9
17	11	13	81	L4	0.30	0.062	0.006	0.174	0.018	0.42	10
18	11	13	81	L4	1.00	0.143	0.011	0.187	0.057	0.87	3
19	11	13	81	L5	0.30	0.068	0.008	0.234	0.019	0.42	12
20	11	13	81	L5	1.00	.	0.014	.	.	.	26
21	12	3	81	L1	0.03	0.034	.	0.098	0.110	0.36	2
22	12	3	81	L1	2.40	0.045	0.006	0.076	0.123	0.48	3
23	12	3	81	L2	0.30	0.035	0.006	0.084	0.107	0.39	2
24	12	3	81	L2	2.40	0.044	0.010	0.074	0.111	0.42	2
25	12	3	81	L3	0.30	0.036	0.008	0.070	0.097	0.45	2
26	12	3	81	L3	1.00	0.034	0.008	0.094	0.099	0.36	2
27	12	3	81	L4	0.30	0.035	0.007	0.092	0.097	0.42	2
28	13	3	81	L4	1.00	0.030	0.007	0.104	0.097	0.45	2
29	13	3	81	L5	0.30	0.035	0.009	0.108	0.092	0.44	3
30	13	3	81	L5	1.00	0.035	0.010	0.112	0.097	0.39	2
							0.008				

LAKE FENWICK STORM DATA

NUTRIENTS, SOLIDS AND DISCHARGE MEARURED DURING THREE STORMS

VALUES EXPRESSED AS MG/L
DISCHARGE AS CFS

OBS	MN	DAY	YR	STATION	SAMPLE	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N	TSS	Q_VOL
1	7	13	81	IN	1	0.220	0.053	0.464	0.096	1.09	44	4608
2	7	13	81	IN	2	0.229	0.094	0.363	0.084	0.90	44	5121
3	7	13	81	IN	3	0.207	0.106	0.314	0.106	1.15	39	7416
4	7	13	81	IN	4	0.216	0.094	0.262	0.086	0.87	37	9972
5	7	13	81	IN	5	0.210	0.104	0.264	0.080	0.98	67	12789
6	7	13	81	IN	6	0.240	0.122	0.324	0.096	1.05	28	14990
7	7	13	81	IN	7	0.200	0.092	0.473	0.078	1.12	20	16569
8	7	13	81	IN	8	0.223	0.094	0.540	0.068	0.98	28	26798
9	7	13	81	IN	9	0.171	0.065	0.820	0.055	1.18	13	11002
10	7	13	81	IN	10	0.138	0.046	1.180	0.041	1.06	7	11331
11	7	13	81	OUT	1	0.170	0.012	0.141	0.097	1.68	15	19566
12	7	13	81	OUT	2	0.205	0.005	0.232	0.041	2.02	19	11092
13	7	13	81	OUT	3	0.197	0.005	0.209	0.040	1.43	20	10442
14	7	13	81	OUT	4	0.191	0.005	0.228	0.029	1.43	20	10290
15	7	13	81	OUT	5	0.163	0.005	0.210	0.030	1.26	18	7884
16	7	13	81	OUT	6	0.171	0.007	0.247	0.028	1.32	17	7020
17	7	13	81	OUT	7	0.188	0.009	0.256	0.031	0.98	15	9096
18	7	13	81	OUT	8	0.184	0.007	0.268	0.022	1.26	14	8087
19	7	13	81	OUT	9	0.224	0.005	0.250	0.018	1.37	16	5938
20	7	13	81	OUT	10	0.191	0.010	0.273	0.026	1.26	14	14598
21	11	11	81	IN	1	0.217	0.030	0.123	0.016	0.73	94	65952
22	11	11	81	IN	2	0.342	0.071	0.250	0.045	1.01	162	26208
23	11	11	81	IN	3	0.325	0.052	0.420	0.062	0.95	94	91724
24	11	11	81	IN	4	0.265	0.067	0.520	0.033	0.73	55	30499
25	11	11	81	IN	5	0.242	0.051	0.470	0.048	0.73	57	34920
26	11	11	81	IN	6	0.230	0.060	0.520	0.054	0.76	53	49061
27	11	11	81	IN	7	0.147	0.046	0.610	0.027	0.59	22	71625
28	11	11	81	IN	8	0.116	0.041	0.880	0.032	0.67	12	24998
29	11	11	81	IN	9	0.114	0.027	1.370	0.040	1.40	11	19566
30	11	11	81	IN	10	0.092	0.032	1.210	0.035	1.40	9	16164
31	11	11	81	OUT	1	0.102	0.044	0.410	0.061	1.06	13	5544
32	11	11	81	OUT	2	0.139	0.005	0.160	0.044	0.95	25	21195
33	11	11	81	OUT	3	0.123	0.007	0.210	0.023	0.73	34	31428
34	11	11	81	OUT	4	0.201	0.023	0.150	0.034	0.73	67	74385
35	11	11	81	OUT	5	0.243	0.043	0.360	0.042	0.73	70	79750
36	11	11	81	OUT	6	0.215	0.039	0.490	0.034	0.67	51	55602
37	11	11	81	OUT	7	0.199	0.038	0.570	0.037	0.70	44	79589
38	11	11	81	OUT	8	0.167	0.040	0.510	0.014	0.70	28	44218
39	11	11	81	OUT	9	0.150	0.041	0.590	0.028	0.84	22	35946
40	11	11	81	OUT	10	0.134	0.030	1.020	0.031	0.66	16	21910
41	12	2	81	IN	1	0.082	.	0.199	0.005	0.31	8	13457
42	12	2	81	IN	2	0.082	.	0.129	0.005	0.31	9	14731
43	12	2	81	IN	3	0.053	.	0.272	0.005	0.39	4	9756
44	12	2	81	IN	4	0.032	.	0.256	0.005	0.53	2	4914
45	12	2	81	IN	5	0.041	.	0.298	0.005	0.98	4	4230
46	12	2	81	IN	6	0.029	.	0.347	0.005	0.48	3	6354
47	12	2	81	IN	7	0.041	.	0.188	0.005	0.28	10	11786
48	12	2	81	IN	8	0.047	.	0.466	0.005	0.47	8	27432
49	12	2	81	IN	9	0.043	.	0.438	0.005	0.70	3	12911
50	12	2	81	IN	10	0.043	.	0.602	0.005	0.56	3	8082
51	12	2	81	OUT	1	0.050	0.005	0.686	0.005	0.50	6	5998

LAKE FENWICK STORM DATA

NUTRIENTS, SOLIDS AND DISCHARGE MEARURED DURING THREE STORMS

VALUES EXPRESSED AS MG/L
DISCHARGE AS CFS

OBS	MN	DAY	YR	STATION	SAMPLE	TP_P	OP_P	NO3NO2_N	NH3_N	TKN_N	TSS	Q_VOL
52	12	2	81	OUT	2	0.055	0.005	0.570	0.010	0.92	8	10872
53	12	2	81	OUT	3	0.054	0.005	0.430	0.021	0.36	8	11880
54	12	2	81	OUT	4	0.053	0.005	0.486	0.019	0.64	10	7632
55	12	2	81	OUT	5	0.051	0.013	0.498	0.017	0.81	9	6552
56	12	2	81	OUT	6	0.055	0.005	0.470	0.013	0.42	7	5181
57	12	2	81	OUT	7	0.038	0.005	0.564	0.016	0.45	7	5967
58	12	2	81	OUT	8	0.066	0.011	0.570	0.012	0.39	8	23058
59	12	2	81	OUT	9	0.099	0.075	0.360	0.015	0.45	7	15253
60	12	2	81	OUT	10	0.058	0.007	0.380	0.012	0.31	6	12013

LAKE FENWICK INLET BASE FLOW MASS POLLUTANT INPUT

TIME PERIOD 1-14-81 THROUGH 11-4-81
ALL VALUES IN KILOGRAMS

OBS	MN	DAY	YR	TP_L	TOP_L	TN_L	TIN_L	TSS_L
1	1	14	81	0.23159	0.06389	12.6175	8.4809	15.972
2	2	23	81	2.10085	0.21245	45.3216	31.0406	70.815
3	3	27	81	4.52527	0.15972	61.7566	21.6148	425.908
4	4	28	81	2.29872	0.16038	41.1632	10.7987	133.647
5	5	12	81	0.35081	0.01332	4.5028	1.0169	53.287
6	5	28	81	0.25755	0.02146	4.9408	1.7385	17.170
7	6	10	81	1.57028	0.17209	12.7343	5.3669	225.862
8	6	25	81	0.62026	0.01980	8.0568	1.3989	59.387
9	7	9	81	.	.	.	.	.
10	7	23	81	.	.	.	.	.
11	8	11	81	.	.	.	.	.
12	8	28	81	.	.	.	.	.
13	10	2	81	4.01951	1.75853	77.2750	26.9809	200.975
14	11	4	81	0.21039	0.01729	2.5305	0.5764	11.528

APPENDIX D

LOADING CALCULATIONS

APPENDIX D

LOADING CALCULATIONS

Two methods were used to calculate loadings of Phosphorus and TSS. One method used average monthly flow the other method used instantaneous flows.

AVERAGE MONTHLY FLOW METHOD

Average monthly flow was determined by estimating the average gage height for each day, converting that height to a flow using the appropriate rating curve, then averaging the daily flow values as required. Concentrations of phosphorus and TSS from routine monitoring were applied to the average discharge to obtain average monthly loads of phosphorus and TSS. Since stormwater has higher concentrations of TP and TSS a correction was applied to account for the difference.

A comparison was made between routine monitoring concentrations and stormwater concentrations as shown in Table D-1. For July and November storms concentrations of TP were approximately two times the normal amount for the month. December had approximately equal concentrations. For TSS the July and December storms had concentrations which were almost double the normal amount while the November storm was over 10 times the normal amount.

TABLE D-1

A COMPARISON OF ROUTINE MONITORING
AND STORMWATER CONCENTRATIONS

	TP-P (mg/l)		TSS (mg/l)	
	Routine	Stormwater	Routine	Stormwater
July	.094	.181	9	15
November	.073	.190	4	46
December	.073	.062	4	8

The average monthly loads include the discharges from storms but do not include the load due to the higher concentrations. Therefore this extra amount must be added. Dates of significant storms were determined from the year long gage height records. Storms were classified as being similar to the July, November or December storms according to the average daily gauge height and time of year. The determinations were made as shown in Table D-2. For each storm an extra load due to higher stormwater concentrations was calculated as shown in Table D-3.

TABLE D-2

METHOD FOR DETERMINING SIMILARITY OF STORMS

	WINTER MONTHS	SUMMER MONTHS
Storm Similar To:	Daily Average Discharge (cfs)	Daily Average Discharge (cfs)
December	$Q \leq 0.5$	$Q \leq 0.2$
July	$0.5 < Q < 1.5$	$0.2 < Q < 1.5$
November	$1.5 \leq Q$	$1.5 \leq Q$

TABLE D-3

METHOD FOR DETERMINING EXTRA STORMWATER LOADS

Storm Similar To:	Added Amount for TP equal to:	Added Amount for TSS equal to:
December	None	Monthly concentration x storm discharge
July	Monthly concentration x storm discharge	" " " "
November	" " " "	9 x monthly concentration x storm drainage

INSTANTANEOUS BASEFLOW METHOD

Baseflow loads were determined by calculating instantaneous loads for each routine lake monitoring trip and interpolating between trips to develop total base flow loads. The stormwater loads were calculated using the same method explained in the previous method. However instead of adding only the amunt due to the higher concentration the total stormwater contribution was added.